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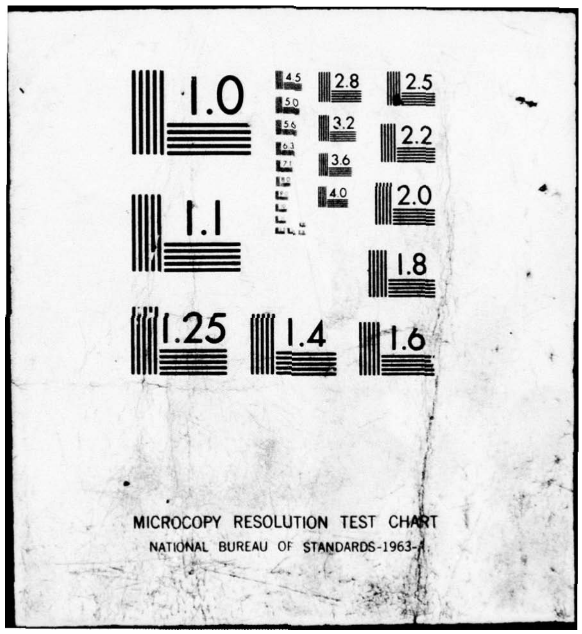
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COMPUTER SOFTWARE FOR
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COMPUTER SOFTWARE FOR EWCS PERFORMANCE PREDICTION.

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U.S. DEPARTMENT OF COMMERCE
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OFFICE OF TELECOMMUNICATIONS
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UNITED STATES DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS

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- Conducts research needed in the evaluation and development of telecommunication policy as required by the Office of Telecommunications Policy, pursuant to Executive Order 11556

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COMPUTER SOFTWARE FOR EWCS PERFORMANCE PREDICTION

E. J. Dutton*

A computer program in FORTRAN IV language entitled PROGRAM PREDIC has been prepared. This calculates performance prediction and its 5 and 95 percent confidence levels for microwave terrestrial links (8 to 30 GHz) operating in the European Wideband Communication System (EWCS). This program predicts atmospheric attenuation, principally due to rain, at the indicated frequencies.

Key Words: Microwave Terrestrial Links, Europe, Path Loss Prediction, Prediction Variability, Rainfall.

1. INTRODUCTION

Given minimal input data on a certain location of its zone, latitude, longitude, and the elevation of the station to within "standard" map accuracy (assumed as 100 ft. or 35 m), it is intended to predict link performance and its 5 and 95 percent confidence limits. Minimal link information of carrier frequency, f, and path length, L, is also required. The prediction methodology is the heart of the computer software, but in order to achieve prediction via so few input parameters, an interpolation procedure, called SUBROUTINE IDBVIP (Akima, 1975), is also required.

This subroutine is a highly sophisticated interpolation procedure, without which historical data of the other input parameters of average annual pressure, temperature, relative humidity, thunderstorm ratio, β, and precipitation M, would be required for each location of interest. Of course, as can be

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seen from the listing of the Appendix, an input option is available to the user if any of these parameters are available at any given location. Otherwise, these data are interpolated from the data of the 249 European data-station sample (Dutton et al., 1974).

There are essentially two predictable uncertainties associated with link performance prediction. First there are S_M^2 and S_β^2, the predicted spatial and temporal variation of M and   within a zone. These are values that would exist even if the interpolation procedure were perfect, as outlined in Dutton et al. (1974). The fact that the interpolation procedure is most likely not perfect, however, introduces the second uncertainties S_{Me}^2 and $S_{\beta e}^2$. The interpolation uncertainty is of consequence for the M and β parameters, which bear directly on rain rate prediction. However, it is not of much consequence for the other parameters, whose bearing upon the prediction process is decidedly minor. Hence, anytime IDBVIP is used to obtain M and β, the second uncertainty must be considered in the confidence level prediction procedure. Since historical data are often not available for arbitrary locations, there is usually no alternative to this interpolation.

We have estimated this prediction uncertainty by zones, choosing a "location" to be one of the stations of the zonal data sample, and using other nearby stations to estimate M and β from IDBVIP. When the interpolated values of M and β are compared with actual station values for all stations in a zone, the zonal rms uncertainty results. It is then not difficult to show that S_{Me}^2 and $S_{\beta e}^2$ can be combined with S_M^2 and S_β^2, the predicted spatial-temporal variances of M and β, as

$$\sigma_M^2 = S_M^2 + S_{Me}^2 \quad , \tag{1}$$

and

$$\sigma_\beta^2 = S_\beta^2 + S_{\beta e}^2 \quad , \tag{2}$$

to produce new variances, σ_M^2 and σ_β^2 of M and β to be used in predicting rain-rate variance instead of S_M^2 and S_β^2 . Note that, in (1) and (2), S_M^2 and S_β^2 are assumed independent of S_{Me}^2 and $S_{\beta e}^2$, respectively. The estimated values of S_M, S_β, S_{Me} and $S_{\beta e}$ are given in Table 1 for those zones pertinent to the EWCS net.

The geographical distribution of zones, of the average annual precipitation, M, and of the thunderstorm ratio, β, were obtained previously by Dutton et al. (1974). They are shown, respectively, in figures 1, 2, and 3.

There are certain limitations of which the user should be aware in this computer software. First, it is not intended for use outside of the EWCS network grid in Europe, or approximately an area enclosed by the latitudes 52°0' on the north and 42°0' on the south, and by the longitudes 1°20' on the west and 25°0' on the east. Second, although the contribution of the gaseous atmosphere was included in Methods 1 and 2, it was not included in Methods 3 and 4. However, in the 8 to 30 GHz region, this is not a severe limitation for the percentages of an average year (0.01 to 1 percent) considered by the software package.

2. FORTRAN PROGRAM PREDIC

The actual software package for the path loss prediction and its variability is a FORTRAN program entitled PREDIC. This program and its concommitant subprograms are described in detail by means of the listing, and comment cards in the Appendix. A brief flow diagram of PROGRAM PREDIC is also given at the end of the Appendix. Only a overview of the program is given here.

The location input variables discussed in section 1 are used to obtain a point distribution of rain rates, R, and its variance S_R^2. They are obtained from SUBROUTINE DELTT. This subroutine requires the zonal S_M^2 and S_β^2, which are stored

Table 1

Estimated spatial-temporal standard deviations and rms uncertainties for the EWCS neteork vicinity

Zone	spatial-temporal deviation of total annual precipitation, S_M (mm.)	rms uncertainty of total annual precipitation, S_{Me} (mm.)	spatial-temporal deviation of thunderstorm ratio S_β (dimensionless)	rms uncertainty of thunderstorm ratio, $S_{\beta e}$ (dimensionless)	Number of data points
2	±249.4	±149.3	±0.09	±0.06	54
4	±203.5	±297.4	±0.08	±0.04	58
6	±590.5	±835.6	±0.10	±0.06	10
8	±285.5	±359.3	±0.07	±0.05	68
9	±421.6	±306.2	±0.09	±0.05	8
10	±139.3	±372.2	±0.10	±0.05	13

in arrays in the main program. A SUBROUTINE TABLES is used as an intermediary to achieve the interpolations discussed in section 1. It stores data from each of the 249 European data stations; to be used as needed by SUBROUTINE IDBVIP.

There are four procedures for estimating mean (50 percent confidence level) path loss due to rain noted in comment cards in the Appendix, that are then incorporated into PREDIC, with the aid of FUNCTIONS GAMMA and REDCO, and SUBROUTINES RAINRT, ATCOS, and PROMO. Briefly, FUNCTION GAMMA obtains the attenuation coefficient per unit rain rate used for the Barsis et al. (1973) and the Battesti et al. (1971) methods. SUBROUTINE RAINRT performs the modification of rain attenuation prescribed by Barsis et al (1973) for terrestrial links. FUNCTION REDCO obtains the necessary parameter for modification of terrestrial link rain attenuation prescribed by Battesti et al. (1971). SUBROUTINES ATCOS and PROMO obtain and modify terrestrial link rain attenuation in accordance with two new procedures.

The user, through an integer parameter called METHOD, is able to select whichever of the procedures he wishes to run, from whence he will acquire a mean path loss due to rain and atmospheric gases for eleven, critically placed, percentages (PCT) of an average year. The variances and confidence levels accounting for year-to-year (temporal) variation and location-to-location variation within the specified zone (spatial) variation are then computed for the same values of PCT, using the results of SUBROUTINE DELTT. The resulting 5 and 95 percent confidence levels of the path loss prediction for the designated values of PCT are then printed, along with the predicted mean path loss.

3. RECOMMENDATIONS

Some attenuation data, taken in the Federal Republic of Germany (F.R.D.) are presented in figures 4 and 6 (CCIR, 1970-1974). These data are compared with four possible prediction methods, designated in the Appendix, as: Methods 1 and 2, corresponding to two extrapolations of the earth/space probability modification factor (Dutton and Dougherty, 1973) to terrestrial link application; Method 3, the method of Barsis et al. (1973); and Method 4, the method of Battesti et al. (1971).

Based on figures 4 and 6, then, it is the personal recommendation of the author that Method 4, the method of Battesti et al. (1971), be tentatively given preference in path performance predictions via PROGRAM PREDIC. This is because it fits the data of figures 4 and 6 reasonably well. It appears from figure 4 that the Method 3 the method Barsis et al. (1973) is best. In figures 5 and 6 it appears that Methods 1 and 2 are best. Based on these results, and the fact that they are his methods, the author would naturally have a predisposition to select either Method 1 or 2. However, the limited size of the data sample analyzed is still justification for caution in this regard. Furthermore, Method 4 was developed in France, and thus, presumably, has applicability to that part of Europe. For the present, the author recommends Method 4; as additional experimental data become available, this recommendation should be reconsidered.

4. REFERENCES

1. Akima, H. (1975), A method of bivariate interpolation and smooth surface fitting for values given at irregularly distributed points, Office of Telecomm. Rept. 75-70, August (AD No. COM 75-11285/AS, NTIS, Springfield, Va.).

2. Barsis, A. P., C. A. Samson, and H. T. Dougherty (1973), Microwave communication links at 15 GHz, USACC Tech. Rept. No. ACC-ACO-2-73 (AD No. 767-545 NTIS, Springfield, Va.).

3. Battesti, J., L. Boithais, and P. Misme (1971), Determination de L'Affaiblissement du a la Pluie pour les Frequencies Superieures a 10 GHz, Ann. Telecomm. (France) Vol. 26, No. 11-12, pp. 439-444, Nov.-Dec.

4. CCIR (1970-1974), Propagation data required for line-of-sight radio-relay systems: statistics of rain attenuation and multipath fading on terrestrial line-of-sight radio-relay links operating at 9 to 15 GHz, Doc 5/145-E, Federal Republic of Germany.

5. Dutton, E. J., H. T. Dougherty, and R. F. Martin Jr. (1974), Prediction of European rainfall and link performance coefficients at 8 to 30 GHz, USACC Tech. Rept. No. ACC-ACO-16-74. (AD No. A000804, NTIS, Springfield, Va.).

6. Dutton, E. J., and H. T. Dougherty (1973), Modeling the effects of clouds and rain upon satellite-to-ground system performance, Office of Telecomm. Tech. Rept. 73-5, March (AD No. COM 75-10802/AS, NTIS, Springfield, Va.).

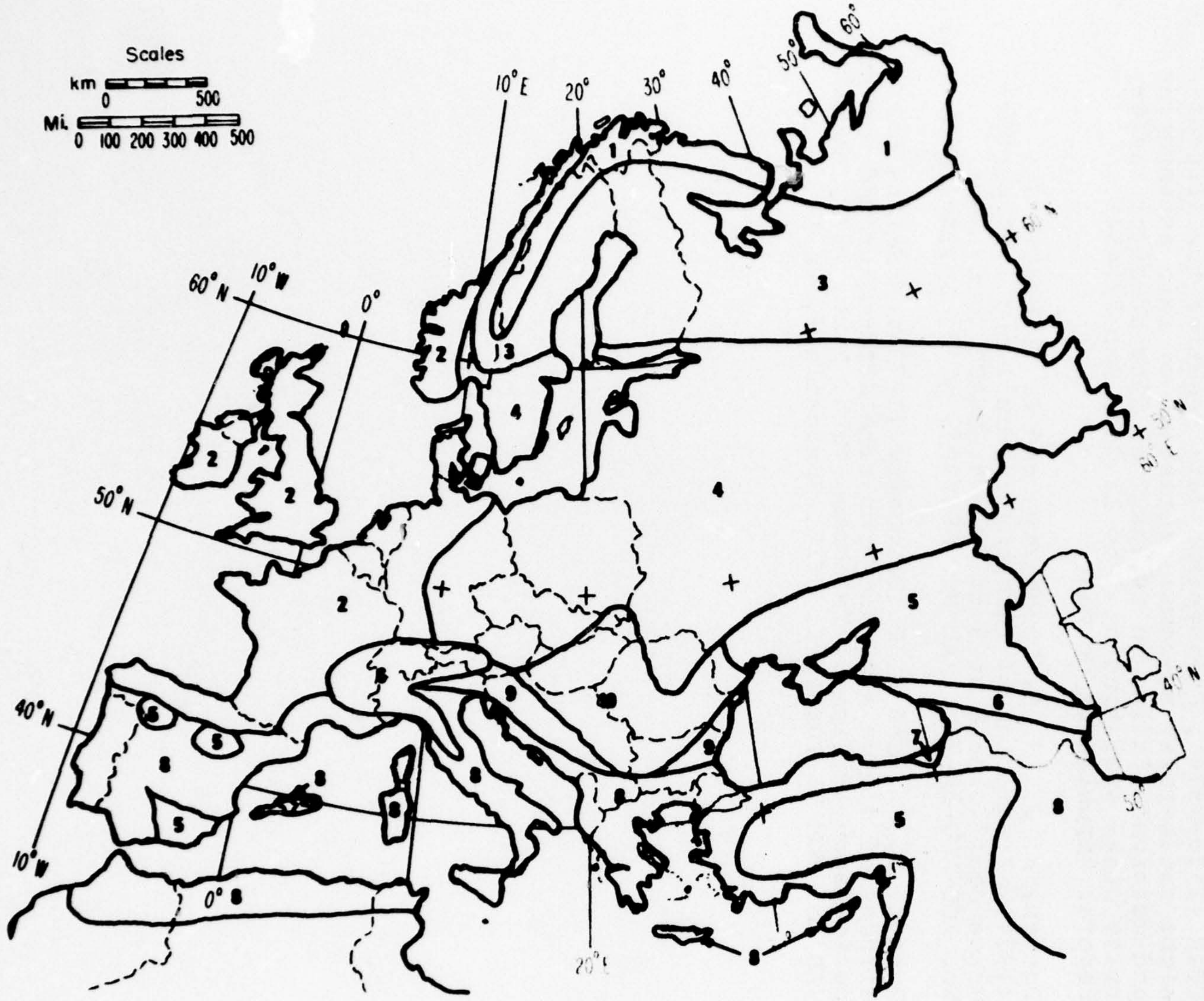

Figure 1. The ten European climatic zones.

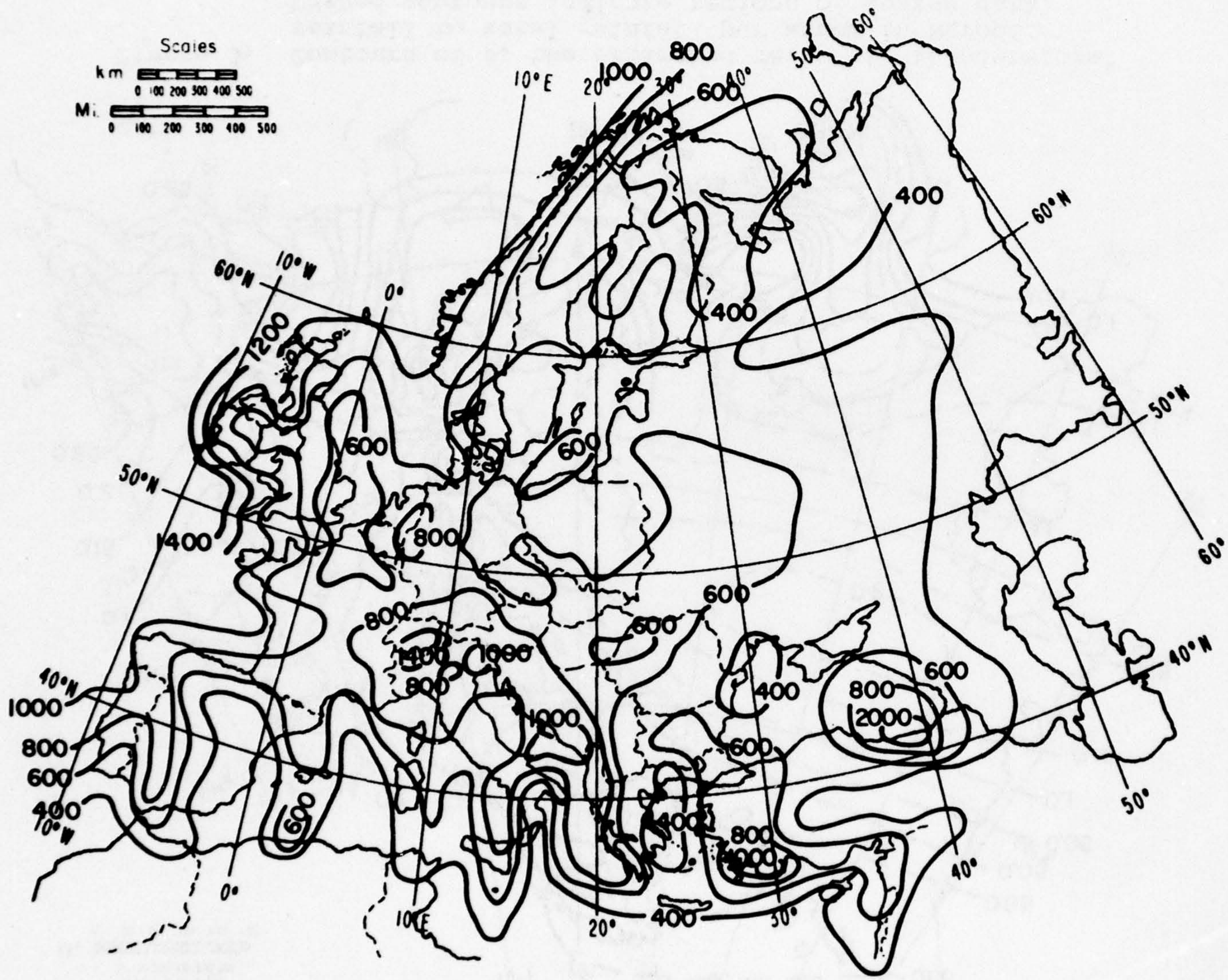

Figure 2. The annual precipitation, M, in millimeters, for an average year in Europe.

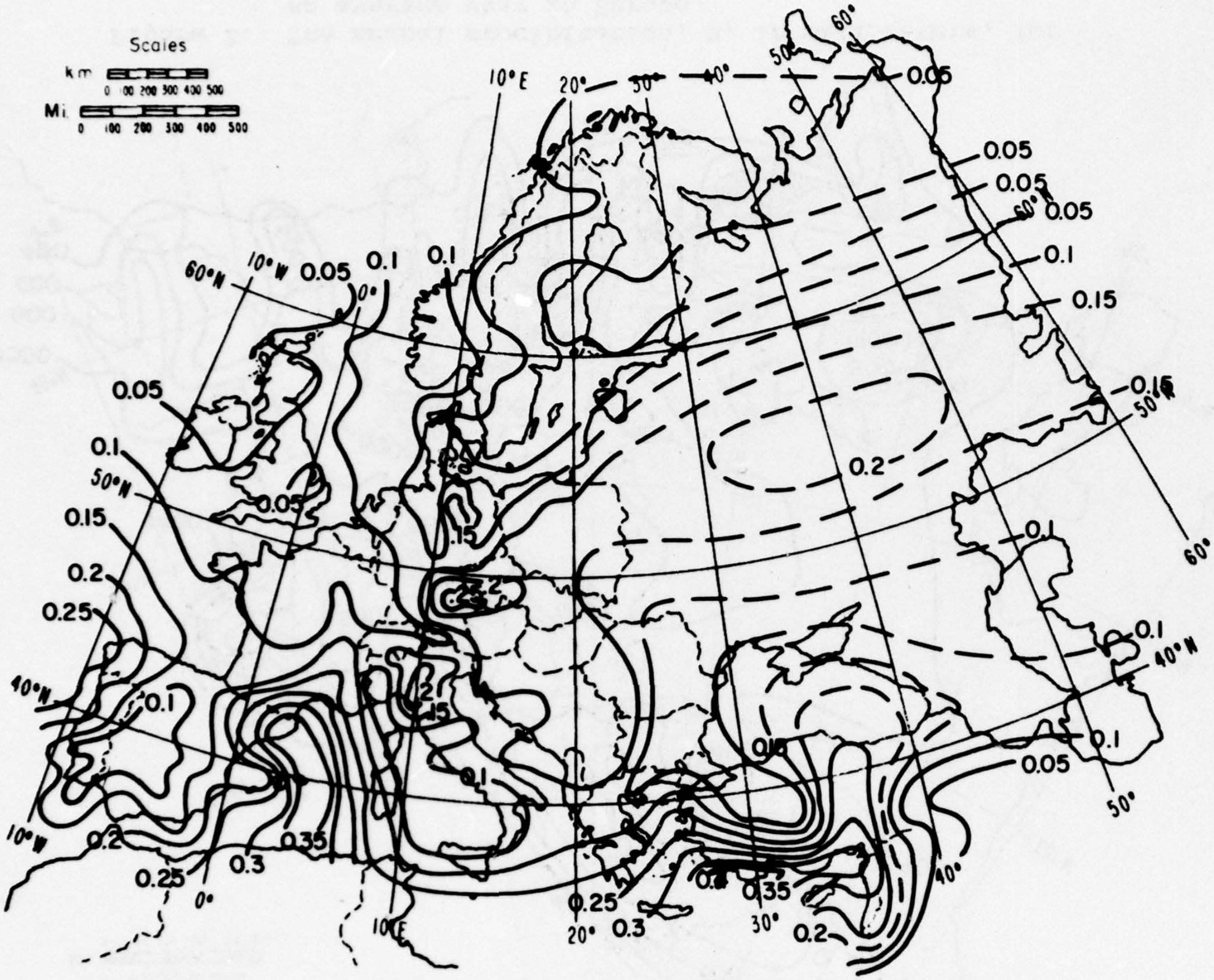

Figure 3. Contours of β, the estimated ratio of "thunderstorm" rainfall to total rainfall per annum in Europe. Dashed contours indicate regions of sparse data.

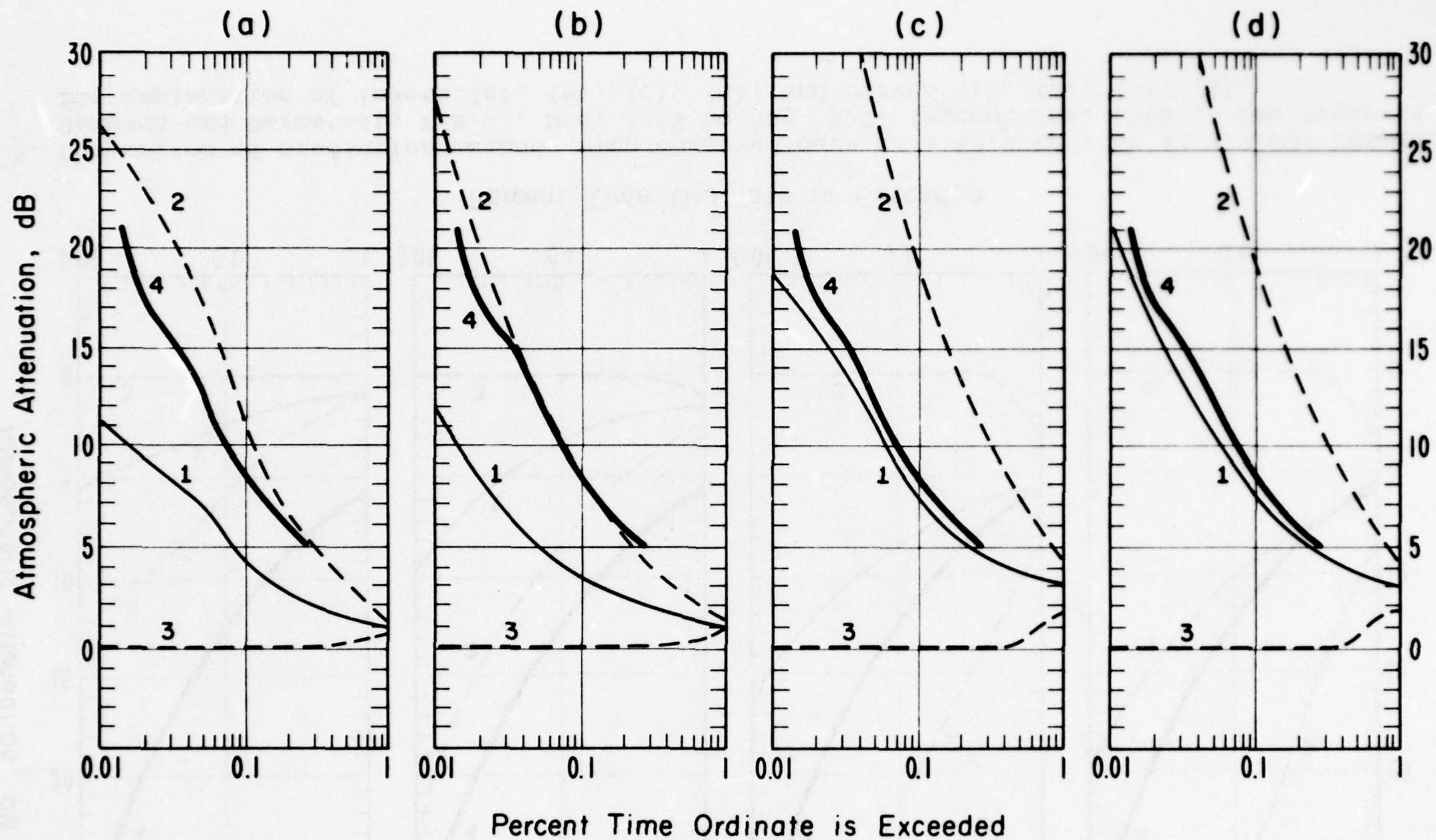

Figure 4. Comparison of prediction methods with observed data on a 25.6 km link at 12.0 GHz between Guntersblum and Darmstadt F.R.D., Dec. 1969 to Nov. 1970. Figure 1a compares the Barsis et al. (1973) method with observations. Figure 1b compares the Battesti et al. (1971) method with observations. Figure 1c compares Method 1 of the Appendix with observations. Figure 1d compares Method 2 of the Appendix with observations. The labels on the curves are: (1), the predicted 50 percent confidence level; (2), the predicted 5 percent confidence level; (3), the predicted 95 percent confidence level; and (4), the observed data.

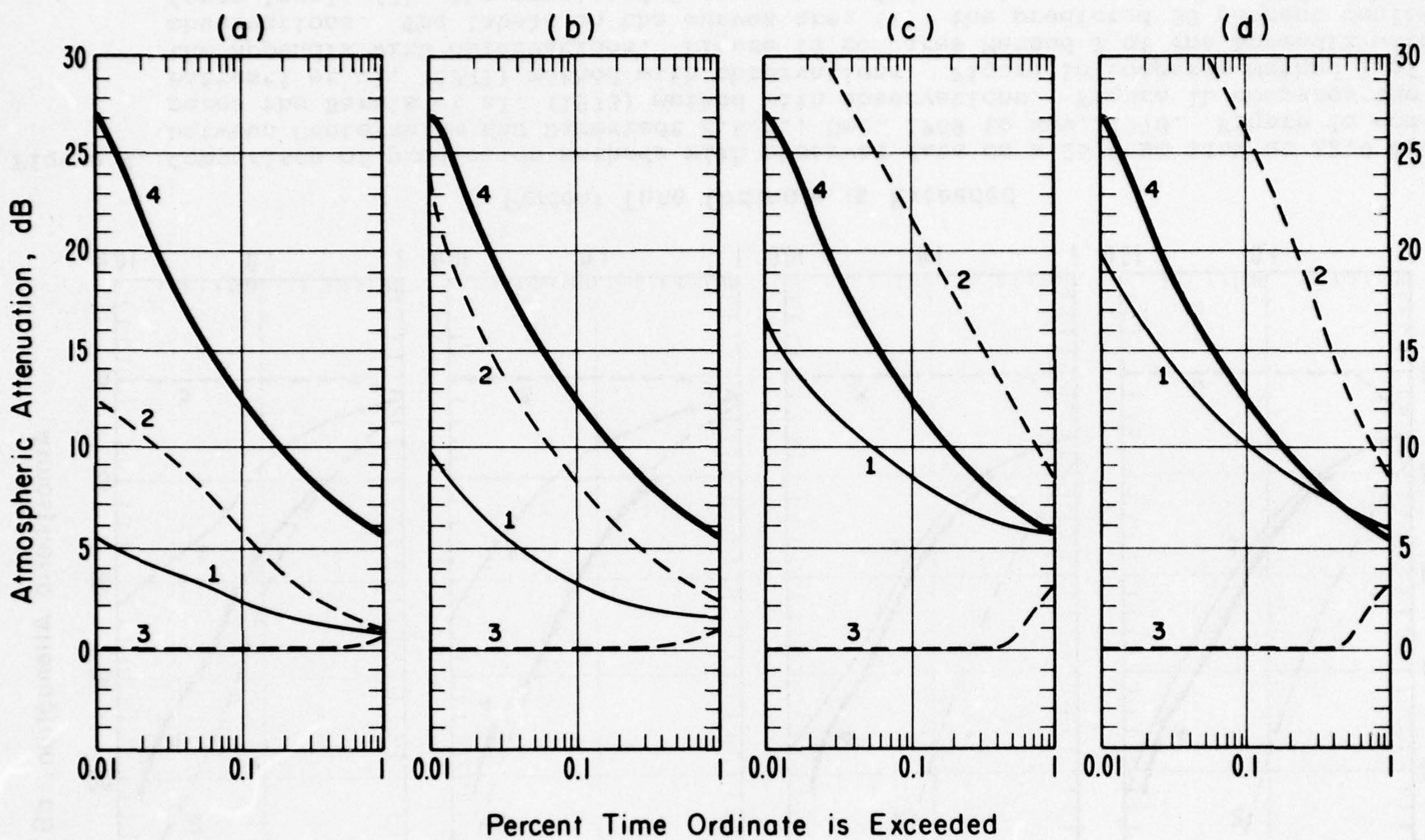

Figure 5. Comparison of prediction methods with observed data on a 69.0 km link at 9.3 GHz between Hambach and Darmstadt, F.R.D., Dec. 1968 to Aug. 1971 (except Jan. 1969). See Figure 4 for explanation of insets (a), (b), (c), (d), and curves (1), (2), (3), (4).

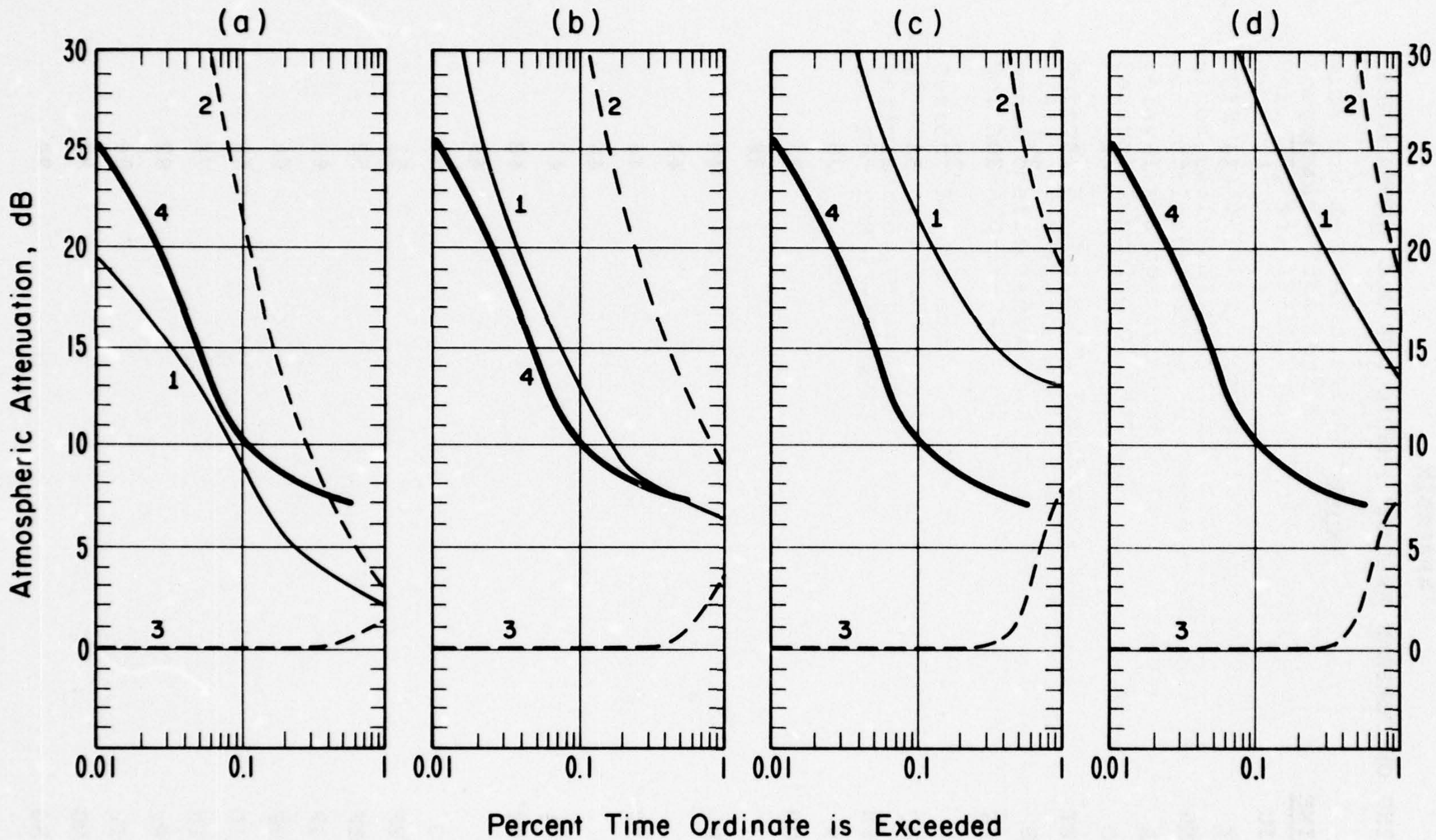

Figure 6. Comparison of prediction methods with observed data on a 69.0 km link at 15.0 GHz between Hambach and Darmstadt, F.R.D., Dec. 1970 to Aug. 1971. See Figure 4 for explanation of insets (a), (b), (c), (d), and curves (1), (2), (3), (4).

APPENDIX

LISTING OF FORTRAN PROGRAM PREDIC AND ALL SUBROUTINES

INDEX

```
      PROGRAM PREDIC(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C     THIS PROGRAM ESTIMATES ATMOSPHERIC ATTENUATION AND ITS 5 AND 95
C     PERCENT CONFIDENCE LIMITS ON MICROWAVE (8 TO 30 GHZ) TERRESTRIAL
C     LINKS FOR THE EUROPEAN WIDEBAND COMMUNICATION SYSTEM (EWCS), BY
C     MEANS OF FOUR DIFFERENT PROCEDURES.  PRIMARY EMPHASIS IS GIVEN TO
C     RAINFALL-CAUSED ATTENUATION.
C
C
C     INPUT --
C
C     TWO CARDS READ.
C
C     FIRST CARD --
C     STATID - ALPHANUMERIC ARRAY FOR INPUT OF ANY IDENTIFYING HEADER
C     OR COMMENTS (COLS 1-80, 8A10).
C     SECOND CARD --
C     XLAT - DEGREE-MINUTES (DD.MM) LATITUDE OF DESIRED LOCATION (COLS
C            1-8, F8.0).
C     XLON - DEGREE-MINUTES (DD.MM) LONGITUDE OF DESIRED LOCATION (COLS
C            9-16, F8.0).
C     ELEV - ELEVATION IN METERS AT DESIRED LOCATION, TO MAP ACCURACY,
C            ASSUMED NEAREST 100 FT OR 35 M (COLS 17-24, F8.0).
C        F - CARRIER FREQUENCY IN GHZ OF TRANSMISSION LINK (COLS 25-32,
C            F8.0).
C        D - DISTANCE ALONG TRANSMISSION PATH (COLS 33-40, F8.0).
C     IZONE - METEOROLOGICAL ZONE APPLYING TO DESIRED LOCATION (COLS 43-
C             44, I2).
C       P1 - AVERAGE ANNUAL SURFACE PRESSURE IN MILLIBARS, IF KNOWN
C             (COLS 47-54, F8.0).
C      RH1 - AVERAGE ANNUAL SURFACE RELATIVE HUMIDITY AS A DECIMAL FRAC-
C             TION, IF KNOWN (COLS 63-70, F8.0).
C       M1 - AVERAGE ANNUAL PRECIPITATION IN MILLIMETERS, IF KNOWN (COLS
C             71-78, F8.0).
C
C.....NOTE -- IF ANY OR ALL OF THE ABOVE METEOROLOGICAL DATA (P1,RH1,M1)
C             FOR THE DESIRED LOCATION IS UNKNOWN, LEAVE THE FIELD FOR
C             THE UNKNOWN PARAMETER BLANK.
C
C
      COMMON/RRATE/RP(12),VRP(12),PCT(12)
      COMMON/PROM/TAUDBT(15),REVTAU(15),RELI(15),HTOP(12)
      DIMENSION NUMSTA(10),STATID(8),TAU5(12,4),TAU95(12,4),TMOD(12,4),
     1VARBET(10),VARM(10),VTAU(12(4),AT(12),RMSBET(10),RMSM(10)
      REAL M,M1
      DATA NUMSTA(1),NUMSTA(2),NUMSTA(3),NUMSTA(4),NUMSTA(5),NUMSTA(6),
     1NUMSTA(7),NUMSTA(8),NUMSTA(9),NUMSTA(10)/3,54,14,58,20,10,1,69,3,
     213/
      DATA RMSBET(1),RMSBET(2),RMSBET(3),RMSBET(4),RMSBET(5),RMSBET(6),
     1RMSBET(7),RMSBET(8),RMSBET(9),RMSBET(10)/0.,0.06,0.,.04,0.,.06,0.,
     2.05,.05,.05/
      DATA RMSM(1),RMSM(2),RMSM(3),RMSM(4),RMSM(5),RMSM(6),RMSM(7),RMSM(
     18),RMSM(9),RMSM(10)/0.0,149.3,0.0,297.4,0.0,835.6,0.0,359.3,306.2,
     2372.2/
      DATA VARBET(1),VARBET(2),VARBET(3),VARBET(4),VARBET(5),VARBET(6),
     1VARBET(7),VARBET(8),VARBET(9),VARBET(10)/.00992,.007762,.009643,
     2.007106,.007744,.009082,0.0,.004706,.007957,.009467/
      DATA VARM(1),VARM(2),VARM(3),VARM(4),VARM(5),VARM(6),VARM(7),
     1VARM(8),VARM(9),VARM(10)/7549.8,64669.,49387.,52132.,18676.,396765
     2.,0.0,87599.,181655.,19687./
```

```
C
C.....READ INPUT DATA.
C
      READ(5,1000)(STATID(I),I=1,8)
      READ(5,1300)XLAT,XLON,ELEV,F,D,IZONE,P1,T1,RH1,M1
C
C. . .OBTAIN INTERPOLATED METEOROLOGICAL DATA (KNOWN DATA AT DESIRED
C. . .LOCATION IS GIVEN PRIORITY).  USER IS AGAIN CAUTIONED THAT, IF
C. . .DATA IS UNKNOWN, TO LEAVE THE SPACES FOR THE DATA ON THE INPUT
C. . .CARD BLANK.  THIS IS THE INPUT OPTION MENTIONED IN THE MAIN TEXT.
C
      CALL TABLES(XLAT,XLON,ELEV,P,T,RH,BET,M)
      IF(P1.GT.0.0) P=P1
      IF(T1.GT.0.0) T=T1
      IF(RH1.GT.0.0) RH=RH1
      IF(M1.GT.0.0) M=M1
C
C. . .OBTAIN VARIANCES OF M AND BETA.
C
      EN=NUMSTA(IZONE)
      VBETA=VARBET(IZONE)+RMSBET(IZONE)*RMSBET(IZONE)
      VEM=VARM(IZONE)+RMSM(IZONE)*RMSM(IZONE)
      GAM=(1.14-0.07*((F-2.)**(1./3.)))*(1.+0.085*(F-3.5)*EXP(-.006*F*F)
     1)
      IF(GAM.LT.1.0) GAM=1.0
      CAY=GAMMA(F)
      WAV=29.9793/F
      CALL DELTT(BET,M,VEM,VBETA)
      DO 105 I=1,11
  105 RELI(I)=PCT(I)
      RELI(12)=100.
C
C.....IF METHOD = 1, THE PROBABILITY MODIFICATION FACTOR, PT1, IS USED.
C.....IF METHOD = 2, THE PROBABILITY MODIFICATION FACTOR, PT2, IS USED.
C.....IF METHOD = 3, THE METHOD OF BARSIS ET AL. (1973) IS USED.
C.....IF METHOD = 4, THE METHOD OF BATTESTI ET AL. (1971) IS USED.
C
C.....CALCULATIONS OF ATTENUATION FOR METHODS 3 AND 4.
C
      DO 100 I=1,11
      IF(RR(I).EQ.0.0)GOTO 220
      GOTO(165,170,175,180,185,190,195,200,205,210),IZONE
  165 HTOP(I)=0.344144*RR(I)+1.14796
      GOTO 215
  170 HTOP(I)=9.466017559*(RR(I)**.182178)
      GOTO 215
  175 HTOP(I)=10.011935574*(RR(I)**0.171134)
      GOTO 215
  180 HTOP(I)=10.444337860*(RR(I)**.1419197)
      GOTO 215
  185 HTOP(I)=14.910713780*(RR(I)**.0765891)
      GOTO 215
  190 HTOP(I)=10.63765431*(RR(I)**.100104)
      GOTO 215
  195 HTOP(I)=14.03480057*(RR(I)**0.0690994)
      GOTO 215
  200 HTOP(I)=5.686529747*(RR(I)**.213556)
      GOTO 215
  205 HTOP(I)=11.68119168*(RR(I)**.109989)
      GOTO 215
```

```
  210 HTOP(I)=12.19431671*(RR(I)**.100871)
  215 IF(HTOP(I).LT.9.0) HTOP(I)=9.0
      GOTO 225
  220 HTOP(I)=9.0
  225 HTOP(12)=10.0
C
C.....CALCULATE METHOD 3.
C
      METHOD=3
      CALL RAINRT(RR(I),D,RM)
      DM=D
      IF(DM.GT.22.0) DM=22.0
      TMOD(I,METHOD)=CAY*(RM**GAM)*DM
      VTAU(I,METHOD)=(TMOD(I,METHOD)*TMOD(I,METHOD)*GAM*GAM/(RR(I)*RR(I)
     1))*VRR(I)
C
C.....CALCULATE METHOD 4.
C
      METHOD=4
      RF=REDCO(D,PCT(I))
      TMOD(I,METHOD)=CAY*((RF*RR(I))**GAM)*D
      VTAU(I,METHOD)=(TMOD(I,METHOD)*TMOD(I,METHOD)*GAM*GAM/(RR(I)*RR(I)
     1))*VRR(I)
      CALL ATCOS(F,T,P,RH,HTOP(I),RELI(I),BET,RR(I),AT(I),WAV)
  100 TAUDBT(I)=AT(I)*D
C
C.....CALCULATIONS OF ATTENUATION FOR METHODS 1 AND 2.
C
      CALL ATCOS(F,T,P,RH,10.0,RELI(12),BET,1.E-6,AT(12),WAV)
      TAUDBT(12)=AT(12)*D
      DO 160 METHOD=1,2
      CALL PROMO(WAV,D,METHOD)
      DO 160 I=1,11
      TMOD(I,METHOD)=REVTAU(I)+TAUDBT(12)
  160 VTAU(I,METHOD)=(TMOD(I,METHOD)*TMOD(I,METHOD)*GAM*GAM/(RR(I)*RR(I)
     1))*VRR(I)
C
C.....CALCULATE 5 AND 95 PERCENT CONFIDENCE LIMITS OF ATTENUATION
C.....DISTRIBUTION FOR ALL METHODS (1-4).
C
      DO 150 METHOD=1,4
      DO 150 I=1,11
      X=1.645*SQRT(VTAU(I,METHOD))
      TAU95(I,METHOD)=TMOD(I,METHOD)-X
      IF(TAU95(I,METHOD).LT.0.0) TAU95(I,METHOD)=0.0
  150 TAU5(I,METHOD)=TMOD(I,METHOD)+X
C
C. . .OUTPUT HEADERS AND RESULTS.
C
      WRITE(6,1400)(STATID(I),I=1,8)
      DO 300 J=1,4
      IF(J.EQ.1) WRITE(6,1450)
      IF(J.EQ.2) WRITE(6,1451)
      IF(J.EQ.3) WRITE(6,1452)
      IF(J.EQ.4) WRITE(6,1453)
      WRITE(6,1500)(PCT(I),I=1,11)
      WRITE(6,2000)(PR(I),I=1,11)
      WRITE(6,2500)(VRR(I),I=1,11)
      WRITE(6,3000)(TMOD(I,J),I=1,11)
      WRITE(6,3500)(VTAU(I,J),I=1,11)
```

```
      WRITE(6,4000)(TAU95(I,J),I=1,11)
  300 WRITE(6,4500)(TAU5(I,J),I=1,11)
      STOP
 1000 FORMAT(8A10)
 1300 FORMAT(5F8.0,2XI2,2X4F8.0)
 1400 FORMAT(1H1,8A10///)
 1450 FORMAT(51H THE PROBABILITY MODIFICATION FACTOR, PT1, IS USED.,//)
 1451 FORMAT(51H THE PROBABILITY MODIFICATION FACTOR, PT2, IS USED.,//)
 1452 FORMAT(44H THE METHOD OF BARSIS ET AL. (1973) IS USED.,//)
 1453 FORMAT(46H THE METHOD OF BATTESTI ET AL. (1971) IS USED.,//)
 1500 FORMAT(1X,12HPCT         = ,11(F9.3,1X)/)
 2000 FORMAT(1X,12HR(MM/HR)    = ,11(F9.3,1X)/)
 2500 FORMAT(1X,12HVAR(R)      = ,11(F9.3,1X)/)
 3000 FORMAT(1X,12HATTEN(DB)   = ,11(F9.3,1X)/)
 3500 FORMAT(1X,12HVAR(ATT)    = ,11(F9.3,1X)/)
 4000 FORMAT(1X,12HATT.(95)    = ,11(F9.3,1X)/)
 4500 FORMAT(1X,12HATT.(5)     = ,11(F9.3,1X)///)
      END
```

```
      BLOCK DATA
C
C     THIS SUBROUTINE INITIALIZES ARRAY PCT IN COMMON/RRATE/.
C
      COMMON/RRATE/RR(12),VRR(12),PCT(12)
      DATA PCT(1),PCT(2),PCT(3),PCT(4),PCT(5),PCT(6),PCT(7),PCT(8),PCT(9
     1),PCT(10),PCT(11),PCT(12)/.01,.015,.02,.03,.05,.08,.1,.2,.5,.8,1.,
     8.001/
      END
```

```
      SUBROUTINE DELTT(BETA,EM,VM,VBET)
C     THIS SUBROUTINE USES THE METHOD OF DUTTON, DOUGHERTY AND MARTIN,
C     (1974), PREDICTION OF EUROPEAN RAINFALL AND LINK PERFORMANCE
C     COEFFICIENTS AT 8 TO 30 GHZ, SECTION 5, PLUS SOME NEW VARIANCE
C     PREDICTION PROCEDURES, TO OBTAIN  VARIATION OF T=1 MIN. RAIN RATES
C     IN TERMS OF ESTIMATED STANDARD DEVIATIONS, BASED ON CURRENTLY
C     AVAILABLE YEAR-TO-YEAR PRECIPITATION DATA.
C
C           INPUT
C
C     BETA=THUNDERSTORM RATIO AT EACH STATION.
C     EM=AVERAGE ANNUAL PRECIPITATION IN MM, AT EACH STATION.
C     VM=VARIANCE OF YEAR-TO-YEAR ANNUAL PRECIPITATION. IT WAS
C     NOT PRESENTED IN THE ABOVE REPORT AND IS THUS REQUIRED AS
C     ADDITIONAL INFORMATION.
C     VBET=VARIANCE OF BETA
C
C           OUTPUT (IN COMMON/RRATE/)
C
C     RR        =T-MINUTE RAIN RATE FROM THE MODIFIED R-H MODEL.
C     VRR    =ESTIMATED      VARIANCE        OF YEAR-TO-YEAR EXPECTED
C     PCT=EXPECTANCY PER YEAR, IN PERCENT, OF TT- MINUTE RAIN RATE (IN
C     DATA STATEMENT).
C
      DIMENSION A1(6),A5(6),A6(6),A7(6),A8(6),B1(6)
     1, B2 (6), B3 (6), B4 (6), B5 (6), B6 (6),            TT (6),
     2 TTR(12),S1(6),S2(6),S3(6),XX(12)
      COMMON/TEST/VRC (12),VRO(12)
      COMMON/RRATE/RR(12),VRR(12),PCT(12)
C
C. . .DATA STATEMENTS CONTAINING COEFFICIENTS FOR MODIFIED RICE-
C. . .HOLMBERG (RH) MODEL PARAMETERS, FOUND IN APPENDIX C OF DUTTON ET
C. . .AL. (1974).
C
      DATA TT(1),TT(2),TT(3),TT(4),TT(5),TT(6)/1.,5.,30.,60.,360.,1440./
      DATA A1(1),A1(2),A1(3),A1(4),A1(5),A1(6)/.009133,.012548,.021934,.
     A027642,.10841,.38794/
      DATA A5(1),A5(2),A5(3),A5(4),A5(5),A5(6)/0.0,-.015782,-.0084347,-.
     A0053345,-.0018022,0.0/
      DATA A6(1),A6(2),A6(3),A6(4),A6(5),A6(6)/0.0,14.313,7.4519,4.6086,
     A1.7116,0.0/
      DATA A7(1),A7(2),A7(3),A7(4),A7(5),A7(6)/0.0,.19983,.10638,.067053
     1,.022986,0.0/
      DATA A8(1),A8(2),A8(3),A8(4),A8(5),A8(6)/34.1329,18.278,12.276,9.2
     1075,2.1793,1.00038/
      DATA B1(1),B1(2),B1(3),B1(4),B1(5),B1(6)/.30045,.30045,.32633,.491
     A68,1.3139,1.8209/
      DATA B2(1),B2(2),B2(3),B2(4),B2(5),B2(6)/207.05,207.05,224.89,338.
     A84,904.18,1254.9/
      DATA B3(1),B3(2),B3(3),B3(4),B3(5),B3(6)/3.5329E-4,-6.6457E-4,
     1-.0013234,-4.9893E-4,-1.7799E-4,-6.262E-5/
      DATA B4(1),B4(2),B4(3),B4(4),B4(5),B4(6)/.24476,1.4071,2.3183,1.14
     101,0.49868,.3022/
      DATA B5(1),B5(2),B5(3),B5(4),B5(5),B5(6)/.0033902,.016705,.025179,
     1.01194,.0045351,.0023186/
      DATA B6(1),B6(2),B6(3),B6(4),B6(5),B6(6)/1.2807,.44634,-.17309,.19
     A847,.083186,.1152/
      DATA S1(1),S1(2),S1(3),S1(4),S1(5),S1(6)/.2823,.0683,.0411,.0285,.
     A0060,0.0/
      DATA S2(1),S2(2),S2(3),S2(4),S2(5),S2(6)/25.0338,25.0338,27.1901,4
```

```
     A0.9674,109.381,151.7197/
      DATA S3(1),S3(2),S3(3),S3(4),S3(5),S3(6)/.0915,.0915,.0884,.0604,.
     A0240,.0166/
      NS=1
      NT=1
      IF (NS .LT. 1) GO TO 165
      DO 160 I = 1, NS
C
C. . .DETERMINE PARAMETERS OF MODIFIED RH MODEL FROM THE ABOVE COEF-
C. . .FICIENTS.
C
      DE = 0.076561 * EM - 83.632 * BETA + 62.523
      VDE=5.8614E-3*VM+6.9943E3*VBET+34.44*34.44
      IF (NT .LT. 1) GO TO 170
      DO 155 J = 1, NT
      T2T = B1 (J) * EM + B2 (J)
      R1T = A5 (J) * EM + A6 (J) * BETA + A7 (J) * DE + A8 (J)
      T1T = BETA * EM / R1T
      RPT = B4 (J) * BETA + B3 (J) * EM + B5 (J) * DE + B6 (J)
      RC = (R1T * RPT * ALOG ((T1T + T2T) / T1T)) / (R1T - RPT)
C
C.....DETERMINE VARIANCES OF THE PARAMETERS IN THE MODIFIED RH MODEL,
C.....AND COMBINE WITH CERTAIN PARTIAL DERIVATIVES (SEE APPENDIX D,
C.....DUTTON ET AL. (1974)).
C
      VRP=VM*(B3(J)+B5(J)*0.076561)**2+VBET*(B4(J)-B5(J)*83.632)**2
     1+B5(J)*B5(J)*34.44*34.44+S3(J)*S3(J)
      VT2=B1(J)*B1(J)*VM+S2(J)*S2(J)
      VR1=VM*(A5(J)+A7(J)*0.076561)**2+VBET*(A6(J)-A7(J)*83.632)**2
     1+A7(J)*A7(J)*34.44*34.44+S1(J)*S1(J)
      VT1=((BETA/R1T)**2.)*VM+((EM/R1T)**2.)*VBET+((BETA*EM/(R1T*R1T))**
     12.)*VR1
      RST = 0.845 / (((30. / R1T) - (5. / RPT)) + ALOG (1. + (T2T / T1T)
     1))
      X = (30. * RPT * RPT) / (ALOG (1. + T2T / T1T) * ((30. * RPT - 5.
     1* R1T) * (30. * RPT - 5. * R1T)))
      Y = (5.0 * RPT * RPT) / (ALOG (1. + T2T / T1T) * ((30. * RPT - 5.
     1* R1T) * (30. * RPT - 5. * R1T)))
      Z = (R1T * RPT * T2T) / ((30. * RPT - 5. * R1T) * (T1T * (T1T + T2
     1T) * (ALOG (1. + T2T / T1T) * * 2.0)))
      W = Z * T1T / T2T
      VRS=(X*X*VR1+Y*Y*VRP+Z*Z*VT1+W*W*VT2)*0.845*0.845
      Q = EXP ((2.340347319 / RST) - (30. / R1T))
      TST = T1T * Q
      U = 30. * T1T * Q / (R1T * R1T)
      V = 2.340347319 * T1T * Q / (RST * RST)
      VTS=Q*Q*VT1+U*U*VR1+V*V*VRS
C
C.....OBTAIN RAIN RATES AND THEIR VARIANCES FOR 12 SELECTED PERCENTAGES
C.....OF AN AVERAGE YEAR.
C
      DO 150 K = 1, 12
      TTR (K) = 87.66 * PCT (K)
      AL=ALOG(TST/TTR(K))
      AL1=ALOG((T1T+T2T)/T1T)
      AL2=ALOG((T1T+T2T)/TTR(K))
      BMR=BETA*EM/(R1T*R1T)
      PRR1T=ALOG(T1T/TTR(K))
      PRT1T=R1T/T1T
      T1=PRT1T*BETA/R1T
```

```
     A0.9674,109.381,151.7197/
      DATA S3(1),S3(2),S3(3),S3(4),S3(5),S3(6)/.0915,.0915,.0884,.0604,.
     A0240,.0166/
      NS=1
      NT=1
      IF (NS .LT. 1) GO TO 165
      DO 160 I = 1, NS
C
C. . .DETERMINE PARAMETERS OF MODIFIED RH MODEL FROM THE ABOVE COEF-
C. . .FICIENTS.
C
      DE = 0.076561 * EM - 83.632 * BETA + 62.523
      VDE=5.8614E-3*VM+6.9943E3*VBET+34.44*34.44
      IF (NT .LT. 1) GO TO 170
      DO 155 J = 1, NT
      T2T = B1 (J) * EM + B2 (J)
      R1T = A5 (J) * EM + A6 (J) * BETA + A7 (J) * DE + A8 (J)
      T1T = BETA * EM / R1T
      RPT = B4 (J) * BETA + B3 (J) * EM + B5 (J) * DE + B6 (J)
      RC = (R1T * RPT * ALOG ((T1T + T2T) / T1T)) / (R1T - RPT)
C
C.....DETERMINE VARIANCES OF THE PARAMETERS IN THE MODIFIED RH MODEL,
C.....AND COMBINE WITH CERTAIN PARTIAL DERIVATIVES (SEE APPENDIX D,
C.....DUTTON ET AL. (1974)).
C
      VRP=VM*(B3(J)+B5(J)*0.076561)**2+VBET*(B4(J)-B5(J)*83.632)**2
     1+B5(J)*B5(J)*34.44*34.44+S3(J)*S3(J)
      VT2=B1(J)*B1(J)*VM+S2(J)*S2(J)
      VR1=VM*(A5(J)+A7(J)*0.076561)**2+VBET*(A6(J)-A7(J)*83.632)**2
     1+A7(J)*A7(J)*34.44*34.44+S1(J)*S1(J)
      VT1=((BETA/R1T)**2.)*VM+((EM/R1T)**2.)*VBET+((BETA*EM/(R1T*R1T))**
     12.)*VR1
      RST = 0.845 / (((30. / R1T) - (5. / RPT)) + ALOG (1. + (T2T / T1T)
     1))
      X = (30. * RPT * RPT) / (ALOG (1. + T2T / T1T) * ((30. * RPT - 5.
     1* R1T) * (30. * RPT - 5. * R1T)))
      Y = (5.0 * RPT * RPT) / (ALOG (1. + T2T / T1T) * ((30. * RPT - 5.
     1* R1T) * (30. * RPT - 5. * R1T)))
      Z = (R1T * RPT * T2T) / ((30. * RPT - 5. * R1T) * (T1T * (T1T + T2
     1T) * (ALOG (1. + T2T / T1T) * * 2.0)))
      W = Z * T1T / T2T
      VRS=(X*X*VR1+Y*Y*VRP+Z*Z*VT1+W*W*VT2)*0.845*0.845
      Q = EXP ((2.340347319 / RST) - (30. / R1T))
      TST = T1T * Q
      U = 30. * T1T * Q / (R1T * R1T)
      V = 2.340347319 * T1T * Q / (RST * RST)
      VTS=Q*Q*VT1+U*U*VR1+V*V*VRS
C
C.....OBTAIN RAIN RATES AND THEIR VARIANCES FOR 12 SELECTED PERCENTAGES
C.....OF AN AVERAGE YEAR.
C
      DO 150 K = 1, 12
      TTR (K) = 87.66 * PCT (K)
      AL=ALOG(TST/TTR(K))
      AL1=ALOG((T1T+T2T)/T1T)
      AL2=ALOG((T1T+T2T)/TTR(K))
      BMR=BETA*EM/(R1T*R1T)
      PRR1T=ALOG(T1T/TTR(K))
      PRT1T=R1T/T1T
      T1=PRT1T*BETA/R1T
```

```
      T2=PRT1T*EM/R1T
      T3=PRR1T-PRT1T*BMR
      PRRST=4.0*(RST**3.0)*(AL**4.0)
      PRTST=PRRST*RST/(TST*AL)
      PRSTRP=-0.845*5.0*R1T*R1T/(((30.*RPT-5.*R1T)**2.0)*AL1)
      T4=PRSTRP*(B3(J)+B5(J)*0.076561)
      PRSTT1=0.845*T2T/(T1T*(T1T+T2T)*AL1*AL1*(30./R1T-5./RPT))
      PRSTT2=-PRSTT1*T1T/T2T
      T6=PRSTT1*BETA/R1T
      T7=PRSTT2*B1(J)
      PTSTT1=0
      T8=PTSTT1*BETA/R1T
      T10=PRSTT1*BETA/R1T
      T11=PRSTT2*B1(J)
      T9=PRSTRP*(B3(J)+B5(J)*0.076561)
      PTSTRS=-V
      T12=PRSTRP*(B4(J)-B5(J)*83.632)
      T13=PRSTT1*EM/R1T
      T14=PTSTT1*EM/R1T
      T15=PRSTRP*(B4(J)-B5(J)*83.632)
      T16=PRSTT1*EM/R1T
      T17=PRSTRP*B5(J)
      PRSTR1=-6.0*(RPT/R1T)*(RPT/R1T)*PRSTRP
      T18=PRSTT1*BMR
      T19=PTSTT1*BMR
      T20=T18
      PTSTR1=U
      PRRPT=AL2
      T21=PRRPT*(B3(J)+B5(J)*0.076561)
      PRT2T=RPT/(T1T+T2T)
      T22=PRT2T*BETA/R1T
      T23=PRT2T*B1(J)
      T24=PRRPT*(B4(J)-B5(J)*83.632)
      T25=PRT2T*EM/R1T
      T30 = T1T * EXP ( - 30. / R1T)
      T5 = (T1T + T2T) * EXP ( - 5. / RPT)
      TC = T1T * EXP ( - RC / R1T)
      RS = - 0.844998 / (ALOG (T30 / T5))
      TS = T30 * EXP ((30. * * 0.25) / RS)
      RI = ( - RS * ALOG (TTR (K) / TS)) * * 4.0
      IF ((RI .LT. 30.0) .AND. (RI .GT. 5.0)) GO TO 100
      RG = - R1T * ALOG (TTR (K) / T1T)
      RL = - RPT * ALOG (TTR (K) / (T1T + T2T))
      GO TO 105
  100 RL=RI
      RG=RI
  105 IF (TTR (K) .GT. TC) GO TO 110
      RR (K) = RG
      GO TO 115
  110 RR (K) = RL
  115 CONTINUE
      IF (TT (J) .GT. 60.0) GO TO 125
      IF (RR (K) .GE. 5.0) GO TO 120
      GO TO 130
  120 IF (RR (K) .GT. 30.0) GO TO 135
      GO TO 140
  125 IF (RR (K) .GT. RC) GO TO 135
  130 VRC (K) = ((VT1 + VT2) *(RPT / (T1T + T2T))**2.)+(VRP*(ALOG((T1T+
     1 T2T)/TTR(K)))**2.)
      VRO (K)=((T21+T22+T23)**2.0)*VM+((T24+T25)**2.0)*VBET
```

```
     1      +((PRRPT*B5(J))**2.0)*34.44*34.44+PRT2T*BMR
     2      *PRT2T*BMR*S1(J)*S1(J)+PRT2T*PRT2T*S2(J)*S2(J)
     3        +PRRPT*PRRPT*S3(J)*S3(J)
      GO TO 145
  135 VRC(K)=VT1*((R1T/T1T)**2.)  + (VR1 *(ALOG (T1T / TTR (K)))**2.)
      VRO (K)=T1*T1*VM+T2*T2*VBET+T3*T3*S1(J)*S1(J)
      GO TO 145
  140 FAC=4.0*((RST*ALOG(TST/TTR(K)))**4.0)
      VRC(K)=((FAC/RST)**2.)*VRS+((FAC/(TST*ALOG(TST/TTR(K))))**2.)*VTS
      VRO (K)=((PRRST*(T4+T6+T7 )+PRTST*(T8+PTSTRS*(T9+T10+T11)))
     1      **2.0)*VM+((PRRST*(T12+T13)+PRTST*(T14
     2        +PTSTRS*(T15+T16)))**2.0)*VBET+((PRRST*T17
     3        +PRTST*PTSTRS*T17)**2.0)*34.44*34.44
     4       +((PRRST*(PRSTR1-T18)+PRTST*(-T19+PTSTR1
     A       +PTSTRS*(PRSTR1-T20)))**2.0)*S1(J)*S1(J)+((PRRST*
     5      PRSTT2+PRTST*PTSTRS*PRSTT2)**2.0)*S2(J)*S2(J)
     6      +((PRRST*PRSTRP+PRTST*PTSTRS*PRSTRP)**2.0)*S3(J)*S3(J)
  145 CONTINUE
  150 CONTINUE
  155 CONTINUE
  170 CONTINUE
  160 CONTINUE
  165 CONTINUE
C
C. . .FIT THE RAIN RATE VARIANCE RESULTS WITH A SMOOTH CURVE FOR PREDIC-
C. . .TION PURPOSES, AND PERFORM THE PREDICTION FOR THE 12 PERCENTS OF
C. . .AN AVERAGE YEAR.
C
      DO 200 I=1,12
      XX(I)=ALOG(ALOG((T1T+0.5*T2T)/TTR(I)))
      VRO(I)=ALOG(VRO(I))
  200 CONTINUE
      CALL LINREG(12,XX,VRO,XBAR,YBAR,B,A,VARX,VARY,COV,SDX,SDY,SER,Z,R)
      AE=EXP(A)
      DO 275 I=1,12
      VRR(I)=AE*((EXP(XX(I)))**B)
  275 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE LINREG (N, X, Y, XBAR, YBAR, B, A, VARX, VARY, COV, SDX
     1, SDY, SER, Z, R)
C
C     PERFORMS A STANDARD LINEAR REGRESSION (Y=BX+A) FITTED THROUGH THE
C     MEAN.
C
C     INPUT
C
C        N - NUMBER OF DATA POINTS
C        X - INDEPENDENT VARIABLES.
C        Y - DEPENDENT VARIABLES.
C
C     OUTPUT
C
C     XBAR - ESTIMATED MEAN OF X.
C     YBAR - ESTIMATED MEAN OF Y.
C        B - SLOPE OF FITTED LINE.
C        A - INTERCEPT OF FITTED LINE.
C     VARX - ESTIMATED VARIANCE OF X.
C     VARY - ESTIMATED VARIANCE OF Y.
C      COV - ESTIMATED COVARIANCE OF X AND Y.
C      SDX - ESTIMATED STANDARD DEVIATION OF X.
C      SDY - ESTIMATED STANDARD DEVIATION OF Y.
C      SER - ESTIMATED STANDARD ERROR OF ESTIMATE.
C        Z - ESTIMATED FISHERS Z.
C        R - ESTIMATED CORRELATION COEFFICIENT.
C
      DIMENSION X (1000), Y (1000)
      SUMX=0.
      SUMY=0.
      SUMXX=0.
      SUMYY=0.
      SUMXY=0.
      EN = N
      IF (N .LT. 1) GO TO 105
      DO 100 I = 1, N
      SUMX = SUMX + X (I)
      SUMY = SUMY + Y (I)
      SUMXY = SUMXY + X (I) * Y (I)
      SUMXX = SUMXX + X (I) * * 2
  100 SUMYY = SUMYY + Y (I) * * 2
  105 CONTINUE
      XBAR = SUMX / EN
      YBAR = SUMY / EN
      VARX = (SUMXX - XBAR * SUMX) / (EN - 1.)
      VARY = (SUMYY - YBAR * SUMY) / (EN - 1.)
      COV = (SUMXY - XBAR * SUMY) / (EN - 1.)
      B = COV / VARX
      A = YBAR - B * XBAR
      SDX = SQRT (VARX)
      SDY = SQRT (VARY)
      R = COV / (SDX * SDY)
      Z = .5 * ALOG ((1. + R) / (1. - R))
      SER = SQRT ((EN - 1.0) * VARY * (1.0 - R * R) / (EN - 2.0))
      RETURN
      END
```

```
      FUNCTION GAMMA(FREQ)
C
C       FREQ IS FREQUENCY IN GHZ BETWEEN 7 GHZ AND 100 GHZ.
C
      DIMENSION F(27),G(27)
C
C       THESE DATA ARE TAKEN FROM THE CCIR CURVES OF ATTENUATION PER KM.
C
      DATA F(1),F(2),F(3),F(4),F(5),F(6),F(7),F(8),F(9),F(10),F(11),F(12
     A),F(13),F(14),F(15),F(16),F(17),F(18),F(19),F(20),F(21),F(22),F(23
     B),F(24),F(25),F(26),F(27)/7.,7.3,7.9,8.4,8.8,9.3,10.,10.5,12.,13.,
     C14.,15.,16.4,17.5,18.5,20.,22.3,26.,29.,32.1,35.,41.,52.,58.,70.,7
     D8.,100./
      DATA G(1),G(2),G(3),G(4),G(5),G(6),G(7),G(8),G(9),G(10),G(11),G(12
     A),G(13),G(14),G(15),G(16),G(17),G(18),G(19),G(20),G(21),G(22),G(23
     B),G(24),G(25),G(26),G(27)/.002,.0025,.003,.004,.005,.0065,.008,.01
     C,.015,.02,.025,.03,.04,.05,.06,.08,.1,.15,.2,.25,.3,.4,.5,.6,.8,1.
     D,1.05/
C
C       GAMMA IS RAIN ATTENUATION COEFFICIENT AT FREQ IN DB/KM/MM/HR.
C
      GAMMA=TERP(28,FREQ,F,G)
      RETURN
      END
```

```
      FUNCTION REDCO(D,T)
C
C     THIS FUNCTION OBTAINS THE REDUCTION FACTOR FOR POINT RAIN RATES
C     USED BY BATTESTI ET AL. (1971).
C
C     INPUT
C
C     D - PATH LENGTH IN KM.
C     T - PERCENT OF TIME OF OPERATION OF CONCERN.
C
      DIMENSION X(12),Y(12),R(3)
      DATA X(1),X(2),X(3),X(4),X(5),X(6),X(7),X(8),X(9),X(10),X(11),X(12
     A)/0.,2.5,5.,7.5,10.,15.,20.,25.,30.,35.,40.,50./
      DATA Y(1),Y(2),Y(3),Y(4),Y(5),Y(6),Y(7),Y(8),Y(9),Y(10),Y(11),Y(12
     A)/1.,.91,.86,.81,.78,.72,.67,.62,.58,.57,.54,.5/
   20 R(1)=1
      R(2)=10.**(-.0036*D)
      IF(D.GT.25.) R(2)=10.**(-.003*D-.05)
      R(3)=TERP(12,D,X,Y)
      IF(T.LT..1) REDCO=((T-.01)/.09)*(R(2)-R(3))+R(3)
      IF(T.GE..1) REDCO=((T-.1)/.9)*(R(1)-R(2))+R(2)
      RETURN
      END
```

```
      SUBROUTINE RAINRT(R0,RSS,RB)
C
C     THIS SUBROUTINE MODIFIES THE RAIN RATE IN ACCORDANCE WITH THE
C     PROCEDURE OF BARSIS ET AL. (1973).
C
C     INPUT
C
C      R0 - UNMODIFIED (POINT) RAIN RATE IN MM/HR.
C     RSS - PATH LENGTH IN KM.
C
C     OUTPUT
C
C     RB - MODIFIED (PATH) RAIN RATE IN MM/HR.
C
      DIMENSION RAT(3),PL(3)
      IF(R0.LE.10.0)225,230
  225 RTB=1.0
      GO TO 250
  230 RAT(1)=-.09076754672*ALOG(R0)+1.209
      PL(1)=5.0
      RAT(2)=-.1889180996*ALOG(R0)+1.435
      PL(2)=10.0
      IF(R0.GT.28.0)235,240
  235 RAT(3)=-.1387074521*ALOG(R0)+1.036771423
      GO TO 245
  240 RAT(3)=-.3959540635*ALOG(R0)+1.911717924
  245 PL(3)=22.0
      RSSS=RSS
      IF(RSSS.GT.22.0) RSSS=22.0
      RTB=TERP(3,RSSS,PL,RAT)
  250 RB=RTB*R0
      RETURN
      END
```

```
      SUBROUTINE ATCOS(FR,T,P,RH,HTOP,PROB,BETA,R,ATE,WAV)
C
C      INPUT
C
C     PROB - PERCENT OF AN AVERAGE YEAR FOR WHICH RESULTS ARE DESIRED
C            RATIO OF THUNDERSTORM RAIN TO NON-THUNDERSTORM RAIN.
C        R - RAIN RATE CORRESPONDING TO PROB AT THE SURFACE OF THE EARTH
C
C      OUTPUT
C
C     TOTAL ATMOSPHERIC ATTENUATION PER UNIT LENGTH IN DB/KM.
C
      PI=3.1416
      TK=T+273.16
      CALL RATTCO(WAV,TK,P,RH,HTOP,0.2,R,AT,PROB,BETA,SCAT,PHIRR)
      SRHO=216.68*ESUBS(TK)*RH/TK
      CALL OXYGEN(TK,P,SRHO,WAV,RWAV,OXAT)
      CALL WATER(TK,P,SRHO,WAV,WN,WAT1,WAT2,PHW)
      IF(FR.LE.45.0) GO TO 200
      CALL TOPOXY(TK,P,WAV,1,OXAT,SRHO,GAMAUP)
  200 ATE=2.0*AT+OXAT+WAT1+WAT2
      CALL REFRAC(4,3,6,T,P,RH,ENS,D0,W0)
      PHIRD=PHIRR+PHW
      PHIT=(2.0E+5*PI/WAV)*(1.0+1.0E-6*ENS)+PHIRD
      RETURN
      END
```

```
      SUBROUTINE CMPLXN (WAVE, T, CSQ, HIMMK, CFPT, CTPT, C, D)
C     THIS SUBROUTINE COMPUTES THE EFFECT OF THE DIELECTRIC CONSTANT OF
C     WATER IN CLOUD ATTENUATION COMPUTATIONS.
C
C               INPUT
C
C     WAVE=WAVELENGTH IN CENTIMETERS.
C     T=TEMPERATURE IN DEGREES CENTIGRADE.
C
C               OUTPUT
C
C     CSQ=DIELECTRIC INFLUENCE OF WATER ON SCAT IN ATTCOE.
C     HIMMK=DIELECTRIC INFLUENCE OF WATER ON ABS IN ATTCOE.
C     CFPT NOT USED IN TEST30.
C     CTPT NOT USED IN TEST30.
C     C=REAL PART OF THE DIELECTRIC COEFFICIENT OF WATER.
C     D=IMAGINARY PART OF THE DIELECTRIC COEFFICIENT OF WATER.
C
      DIMENSION E00 (6), DDLAM (6), TTAB (6)
      TTAB (1) = 0.0
      E00 (1) = 88.0
      DDLAM (1) = 3.59
      TTAB (2) = 10.0
      E00 (2) = 84.0
      DDLAM (2) = 2.24
      TTAB (3) = 18.0
      E00 (3) = 81.0
      DDLAM (3) = 1.66
      TTAB (4) = 20.0
      E00 (4) = 80.0
      DDLAM (4) = 1.53
      TTAB (5) = 30.0
      E00 (5) = 76.4
      DDLAM (5) = 1.12
      TTAB (6) = 40.0
      E00 (6) = 73.0
      DDLAM (6) = 0.859
      EIN = 5.5
      E0 = TERP (6, T, TTAB, E00)
      DLAM = TERP (6, T, TTAB, DDLAM)
      B = DLAM / WAVE
      A = (E0 - EIN) / (1.0 + (B * * 2))
      C = EIN - 1.0
      D = EIN + 2.0
      E = A + C
      H = A + D
      G = A * B
      HIMMK = (G * (H - E)) / ((H * * 2) + (G * * 2))
      CSQ = (((E * H + (G ** 2)) / ((H ** 2) + (G ** 2))) ** 2) + HIMMK
     1 ** 2
      C = A + EIN
      D = - A * B
      U = D / 45.
      V = ((20. * C * D + 10. * D) * (15. * (C * * 2) - 15. * (D * * 2)
     1+ 60. * C + 60.) + (30. * C * D + 60. * D) * ( - 10. * (C * * 2) +
     2 10. * (D * * 2) - 10. * C + 20.)) / ((15. * (C * * 2) - 15. * (D
     3* * 2) + 60. * C + 60.) * * 2 + (30. * C * D + 60. * D) * * 2)
      W = ((12. * C * D - 18. * D) * (15. * (C * * 2) - 15. * (D * * 2)
     1+ 60. * C + 60.) + (30. * C * D + 60. * D) * ( - 6. * (C * * 2) +
     26. * (D * * 2) + 18. * C - 12.)) / ((15. * (C * * 2) - 15. * (D *
```

```
3* 2) + 60. * C + 60.) * * 2 + (30. * C * D + 60. * D) * * 2)
 Y = (D * (30. * C + 45.) - 30. * D * (C - 1.)) / ((30. * C + 45.)
1* * 2 + (30. * D) * * 2)
 CFPT = 3. * U + 3. * W + 5. * Y
 CTPT = 3. * V
 RETURN
 END
```

```
      FUNCTION ESUBS (T)
C
C     THIS SUBROUTINE CALCULATES SATURATION VAPOR PRESSURE OF WATER IN
C     AIR AT TEMPERATURE T IN DEGREES KELVIN.
C
      X = .05 * (T - 243.)
      Y = 26.461779 - X * (.336222 - (X - 1.) * (.9889E-2 - (X - 2.) * (
     1.144666E-3 + (X - 3.) * .225E-4)))
      ESUBS = EXP (Y - 6594.4074 / T)
      IF (T - 283.)105, 105, 100
  100 ESUBS = ESUBS + (100. - (T - 293.) * * 2) * 8.E-6
  105 RETURN
      END
```

```
      SUBROUTINE REFRAC (KT, KP, KH, TM, PR, HU, EN, D, W)
C     SPECIFIC LOCATIONS (HEIGHTS) IN THE ATMOSPHERE FOR VARIOUS KINDS
C     THIS SUBROUTINE CALCULATES THE REFRACTIVITY (REFRACTIVE INDEX) AT
C     OF METEOROLOGICAL INPUT PARAMETERS.
C
C               INPUT
C
C     KT=4, MEANS TEMPERATURE INPUT IN DEGREES CENTIGRADE.
C     KP=3, MEANS PRESSURE INPUT IN MILLIBARS.
C     KH=6, MEANS RELATIVE HUMIDITY INPUT AS A DECIMAL FRACTION.
C     TM=TEMPERATURE IN DEGREES CENTIGRADE.
C     PR=PRESSURE IN MILLIBARS.
C     HU=RELATIVE HUMIDITY AS A DECIMAL FRACTION.
C
C               OUTPUT
C
C     EN=REFRACTIVITY IN N-UNITS (PARTS PER MILLION OF REFRACTIVE INDEX)
C     D=DRY TERM OF REFRACTIVITY IN N-UNITS.
C     W=WET TERM OF REFRACTIVITY IN N-UNITS.
C
      T = TM
      P = PR
      H = HU
      GO TO (100, 105, 110, 115, 120), KT
  100 T = T - 459.69
  105 T = .555555555 * T - 17.7777777
      GO TO 115
  110 T = 1.25 * T
  115 T = T + 273.
  120 GO TO (125, 130, 135), KP
  125 P = 25.4 * P
  130 P = 1.333224 * P
  135 GO TO (140, 140, 175, 180, 185, 190, 195), KH
  140 GO TO (145, 150, 155, 160, 165), KT
  145 H = H - 459.69
  150 H = .555555555 * H - 17.7777777
      GO TO 160
  155 H = 1.25 * H
  160 H = H + 273.
  165 E = ESUBS (H)
      GO TO (215, 170), KH
  170 E = E - (.66E-3 * (1. + .115E-2 * (H - 273.))) * (T - H) * P
      GO TO 215
  175 H = H / (1. - H * 1.E-3)
  180 H = H * 1.E-3
      X = T - 273.
      FW = 1.00044 - X * (.23E-4 + .175E-6 * X) + (.39E-5 + X * (.45E-9
     1* X - .285E-7)) * P
      E = H * P / (FW * (H + .62197))
      GO TO 215
  185 E = 4.6150136 * H * T
      GO TO 215
  190 E = H * ESUBS (T)
      GO TO 215
  195 GO TO (200, 205, 210), KP
  200 H = 25.4 * H
  205 H = 1.333224 * H
  210 E = H
  215 W = 373256. * E / T * * 2
      D = 77.6 * P / T
      EN = W + D
      RETURN
      END
```

```
      SUBROUTINE OXYGEN (T, R, RHO, PLAMDA, RWAV, GAMAU)
C     THIS SUBROUTINE CALCULATES ATMOSPHERIC ABSORPTION PER UNIT LENGTH
C     DUE TO ATMOSPHERIC OXYGEN FOR FREQUENCIES ROUGHLY IN THE RANGE
C     5-45 GHZ. USES VAN VLECK FORMULATION (SEE RADIO METEOROLOGY, PAGE
C     272).
C
C              INPUT
C
C     T=TEMPERATURE IN DEGREES KELVIN, AT LOCATION ON TRANSMISSION PATH
C     OF INTEREST.
C     R=PRESSURE IN MILLIBARS AT LOCATION ON TRANSMISSION PATH OF
C     INTEREST.
C     RHO=ATMOSPHERIC WATER VAPOR DENSITY IN G/M(3), AT LOCATION ON
C     TRANSMISSION PATH OF INTEREST.
C     PLAMDA=WAVELENGTH IN CENTIMETERS.
C
C              OUTPUT
C
C     RWAV=RECIPROCAL OF WAVELENGTH.
C     GAMAU=OXYGEN ABSORPTION IN DB/KM.
C
      PW = (4.615E-3) * RHO * T
      P = R - PW
      D = 0.049 * (P / 1013.25) * ((300. / T) * * .75)
      RWAV = 1. / PLAMDA
      RWAV2 = RWAV * RWAV
      D2 = D * D
      F1 = D / (RWAV2 + D2)
      F2 = D / ((RWAV - 2.) * * 2 + D2)
      F3 = D / ((RWAV + 2.) * * 2 + D2)
      GAMAU = .34 * RWAV2 * ((293. / T) * * 2) * (F1 + F2 + F3) * (P / 1
     1013.25)
      RETURN
      END
```

```
      SUBROUTINE WATER (T, P, RHO, WAVE, WN, GAMAR, GAMANR, PHW)
C     THIS SUBROUTINE CALCULATES ATMOSPHERIC ABSORPTION PER UNIT LENGTH
C     DUE TO ATMOSPHERIC WATER VAPOR FOR FREQUENCIES ROUGHLYIN THE RANGE
C     5-70 GHZ. USES VAN VLECK FORMULATION (SEE RADIO METEOROLOGY, PG.
C     272).
C
C               INPUT
C
C     T=TEMPERATURE IN DEGREES KELVIN, AT LOCATION ON TRANSMISSION
C     PATH OF INTEREST.
C     P=PRESSURE IN MILLIBARS, AT LOCATION ON TRANSMISSION PATH OF
C     INTEREST.
C     RHO=ATMOSPHERIC WATER VAPOR DENSITY IN G/M(3), AT LOCATION ON
C     TRANSMISSION PATH OF INTEREST.
C     WAVE=WAVELENGTH IN CENTIMETERS.
C
C               OUTPUT
C
C     WN=RECIPROCAL OF WAVELENGTH.
C     GAMAR=CONTRIBUTION OF WATER RESONANCE LINE.
C     GAMANR=NON-RESONANT CONTRIBUTION TO WATER VAPOR ABSORPTION IN
C     DB/KM.
C     PHW=PHASE DISPERSION DUE TO WATER VAPOR IN RADIANS/KM.
C
      F = 29.9793 / WAVE
      F0 = 22.23515
      DF = F0 - F
      C1 = 0.00361
      C2 = 0.06089
      A = 0.08478 * (P / 1013.25)
      B = 0.00705
      WN = 1. / WAVE
      WNR = 0.7417
      X = 318. / T
      D = A * (1. + B * RHO) * (X * * 0.625)
      FORMM = (WN - WNR) * * 2 + D * * 2
      FORMM = 1. / FORMM
      FORMP = (WN + WNR) * * 2 + D * * 2
      FORMP = 1. / FORMP
      FORM = D * (FORMM + FORMP)
      TT = (X * * 2.5) * EXP ( - 644. * (1. / T - 1. / 318.))
      YR = C1 * TT * FORM * (WN * * 2)
      YNR = C2 * D * X * (WN * * 2)
      GAMAR = YR * RHO
      GAMANR = YNR * RHO
      GG=0.0186823*RHO+0.0028129*(P-RHO*T/216.68)*((300.0/T)**0.63)
      PHW=(4.19169E-2)*F*0.110132*DF/(DF*DF+GG*GG)
      RETURN
      END
```

```
      SUBROUTINE RATTCO(WAVE,TA,PRE,REL,HITE,ZHH,RO,AT,RELY,BETA,SCATR,
     1PHIR)
C     THIS SUBROUTINE CALCULATES RAIN ATTENUATION, PROVIDED AN
C     AIR/GROUND PATH IS USED FROM SURFACE METEOROLOGICAL DATA AND
C     RELIABILITY REQUIREMENTS.
C
C               INPUT
C
C     WAVE=WAVELENGTH IN CENTIMETERS.
C     TA=SURFACE TEMPERATURE IN DEGREES KELVIN.
C     PRE=SURFACE PRESSURE IN MILLIBARS.
C     REL=SURFACE RELATIVE HUMIDITY AS A DECIMAL FRACTION.
C     HITE=STORM TOP HEIGHT IN KILOMETERS.
C     ZHH=HEIGHT ABOVE EARTHS SURFACE IN KILOMETERS.
C     RO=SURFACE RAINFALL RATE IN MILLIMETERS PER HOUR.
C     RELY=PERCENT OF AN AVERAGE YEAR.
C     BETA=RATIO OF THUNDERSTORM RAIN TO NON-THUNDERSTORM RAIN (SEE
C     EARLIER REFERENCE IN TEST30).
C
C               OUTPUT
C
C     SCATR=RAINFALL REFLECTIVITY IN KM(-1).
C     PHIR=PHASE DELAY PER UNIT LENGTH DUE TO RAIN, IN RADIANS/KM.
C     AT=ATTENUATION COEFFICIENT DUE TO RAIN IN DB/KM.
C
      DIMENSION PF (3), FACT (3)
      DATA PF(1),PF(2),PF(3)/.01,.1,1./
      FR = 29.9793 / WAVE
      CALL SFCG (TA, REL, PRE, HITE, ZHH, RO, EMZ1, EMZ2, BETA, RELY, UN
     1W)
      CALL CRANE (FR, A, B, A1, B1)
      TAC = TA - 273.16
      CALL CMPLXN (WAVE, TAC, CSQ, HIMMK, CFPT, CTPT, CC, DD)
      FP = 0.025970 * FR - 0.50135
      IF (FR .LE. 19.31) FP = 0.0
      FQ = 0.0148888889 * FR - 0.402
      IF (FR .LE. 27.0) FP = 0.0
      FACT (1) = 1.0 + FP
      FACT (2) = 1.0 + FQ
      FACT (3) = 1.0
      FAC = TERP (3, RELY, PF, FACT)
      IF (RELY .GT. 1.0) FAC = 1.0
      U = (0.3 * 3.1415927 / WAVE) * (FAC * ((CC - 1.) * (CC + 2.) + DD
     1* DD)) / ((CC + 2.) * (CC + 2.) + DD * DD)
      PHIR = U * EMZ1
      AT = A * (EMZ1 * * B)
      IF ((ABS (RELY - 0.1)) .LT. 0.01) AT = BETA * A * (EMZ1 * * B)  +
     1(1. - BETA)  * A * (EMZ2 * * B)
      IF ((ABS (RELY - 0.1)) .LT. 0.01) PHIR = BETA * U * EMZ1 + (1. - B
     1ETA)  * U * EMZ2
      IF ((RELY - 0.1) .GE. 0.01) AT = A * (EMZ2 * * B)
      IF ((RELY - 0.1) .GE. 0.01) PHIR = U * EMZ2
      C = (2.E-7 / 3.) * (306.01812) * CSQ / (WAVE * * 4)
      X = C * A1 * (EMZ1 * * B1)
      Y = C * A1 * (EMZ2 * * B1)
      E = 0.64 * B1
      SCATR = Y
  100 RETURN
      END
```

```
      SUBROUTINE SFCG (TA, REH, PR, HGT, ZH, RO, EMZ1, EMZ2, BETA, RELY,
     1 T)
C     THIS SUBROUTINE CALCULATES THE LIQUID WATER CONTENT IN A RAIN-
C     STORM. DETAILS ARE IN A METEOROLOGICAL MODEL FOR USE IN THE STUDY
C     OF RAINFALL EFFECTS ON ATMOSPHERIC RADIO TELECOMMUNICATIONS, BY
C     E.J. DUTTON, OFFICE OF TELECOMMUNICATIONS REPORT OT/TRER 24,
C     DECEMBER, 1971.
C
C                 INPUT
C
C     TA=SURFACE TEMPERATURE IN DEGREES KELVIN.
C     REH=SURFACE RELATIVE HUMIDITY AS A DECIMAL FRACTION.
C     PR=SURFACE PRESSURE IN MILLIBARS.
C     HGT=STORM TOP HEIGHT IN KILOMETERS.
C     ZH=HEIGHT ABOVE EARTHS SURFACE IN KILOMETERS.
C     RO=SURFACE RAINFALL RATE IN MM/HR.
C     BETA=RATIO OF THUNDERSTORM RAIN TO NON-THUNDERSTORM RAIN (SEE
C     PREVIOUS REFERENCE).
C     RELY=PERCENT OF AN AVERAGE YEAR.
C
C                 OUTPUT
C
C     EMZ1=CONTRIBUTION IN G/M(3) OF CONVECTIVE RAINSTORMS TO LIQUID
C     WATER CONTENT.
C     EMZ2=CONTRIBUTION IN G/M(3) OF STRATIFORM RAINSTORMS TO LIQUID
C     WATER CONTENT.
C
      REAL L
      Z = 1000. * ZH
      HIT = 1000. * HGT
      C1 = 1.9031
      C2 = 1.5625
      TD = TA / (1. - 1.8594E-4 * TA * ALOG (REH))
      L = (123. + .227 * (TD - 273.16)) * (TA - TD)
      HTE = ((RO / C1) * * (1. / C2)) + (2. * L / 1852.0)
      IF ((Z / 1852.0) .LT. HTE)110, 105
  105 EMZ1 = 0.0
      GO TO 115
  110 RR = C1 * (((HTE - (L / 1852.0)) - ABS ((Z - L) / 1852.0)) * * C2)
      BZ = 8.2 * (RR * * ( - .21))
      EMZ1 = 64. * 3.1415927 * (BZ * * ( - 4))
  115 B = 8.2 * (RO * * ( - .21))
      EML = 64. * 3.1415927 * (B * * ( - 4))
      IF (Z .LE. L)100, 120
  100 EMZ2 = EML
      T = TA - Z * 9.8E-3
      GO TO 125
  120 TL = TA - L * 9.8E-3
      E = ESUBS (TL)
      P = PR * EXP ((980.62 / 28704.) * ( - L) * (2. / (TA + TL)))
      W = (E * .622) / P
      TS = 9.8E-3 * ((1. + (W * 597.3 / (TL * 6.8557E-2))) / (1. + ((W *
     1 22.191E4) / (TL * TL * 1.64537E-2))))
      T = TA - L * 9.8E-3 - (Z - L) * TS
      EXZ = EXP ( - .064 * TS * (Z - L))
      EXH = EXP ( - .064 * TS * (HIT - L))
      TBZ = TL - .5 * TS * (Z - L)
      TBH = TL - .5 * TS * (HIT - L)
      G = (.622 / (T * 2.8704E-3)) * ( - .064 * TS * E * EXZ + (980.62 *
     1 E * EXZ / (T * 2.8704E4)))
```

```
      R = 2.8704E-3
      R1 = 2.8704E4
      GAMZ = ((.622 * E / (R * TBZ)) * (EXZ - 1.) - (.622 * 980.62 * E /
     1 (.064 * TS * R * R1 * TBZ * TBZ)) * (EXZ - 1.))
      GAMH = ((.622 * E / (R * TBH)) * (EXH - 1.) - (.622 * 980.62 * E /
     1 (.064 * TS * R * R1 * TBH * TBH)) * (EXH - 1.))
      EMZ2 = EML * (1. - (GAMZ / GAMH))
      IF(EMZ2.LT.0.0) EMZ2=0.0
  125 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE CRANE (F, A, B, C, D)
C     THIS SUBROUTINE GETS THE COEFFICIENTS A AND B IN A*(M**B) AND
C     C AND D IN C*(M**D) FOR (INPUT) FREQUENCY, F, BELOW 94 GHZ,
C     FOLLOWING CRANE, R.K., MICROWAVE SCATTERING PARAMETERS FOR NEW
C     ENGLAND RAIN, MIT LINCOLN LABORATORIES REPORT R TR 426, AD 647798,
C     OCT. 1966.
C     THE OUTPUTS ARE A AND B, COEFFICIENTS IN COMPUTING ATTENUATION
C     COEFFICIENT, C AND D, COEFFICIENTS USED IN COMPUTING REFLECTIVITY
C     PER UNIT VOLUME.  M IS LIQUID WATER CONTENT IN G/M(3), BUT IS NOT
C     OUTPUT OF THIS ROUTINE.  THE SUBROUTINE USES THE APPROXIMATE F
C     SQUARED ABSORPTION DEPENDENCY.
C
      DATA X1,X2,X3,X4/.1,1.,.1,1./
      IF (F .LT. 1.29) GO TO 160
      IF (F .LT. 2.8) GO TO 100
      IF (F .LT. 8.0) GO TO 125
      IF (F .LT. 9.35) GO TO 130
      IF (F .LT. 15.5) GO TO 135
      IF (F .LT. 35.0) GO TO 140
      IF (F .LT. 70.0) GO TO 145
      IF (F .LT. 94.0) GO TO 150
      WRITE(6,1502)
  100 Y1 = 1.8E-4
      Y2 = 1.8E-3
      Y3 = 9.1E-4
      Y4 = 1.05E-2
      F1 = 1.29
      F2 = 2.8
      GO TO 155
  125 Y1 = 9.1E-4
      Y2 = 1.05E-2
      Y3 = 1.3E-2
      Y4 = 0.18
      F1 = 2.8
      F2 = 8.0
      GO TO 155
  130 Y1 = 1.3E-2
      Y2 = 0.18
      Y3 = 2.0E-2
      Y4 = 0.32
      F1 = 8.0
      F2 = 9.35
      GO TO 155
  135 Y1 = 2.0E-2
      Y2 = 0.32
      Y3 = 6.1E-2
      Y4 = 1.3
      F1 = 9.35
      F2 = 15.5
      GO TO 155
  140 Y1 = 6.1E-2
      Y2 = 1.3
      Y3 = 0.41
      Y4 = 5.8
      F1 = 15.5
      F2 = 35.0
      GO TO 155
  145 Y1 = 0.41
      Y2 = 5.8
      Y3 = 1.5
```

```
      Y4 = 10.1
      F1 = 35.0
      F2 = 70.0
      GO TO 155
150   Y1 = 1.50
      Y2 = 10.1
      Y3 = 1.40
      Y4 = 12.0
      F1 = 70.0
      F2 = 94.0
155   B1 = ALOG (Y2 / Y1) / ALOG (X2 / X1)
      A1 = Y1 / (X1 * * B1)
      B2 = ALOG (Y4 / Y3) / ALOG (X4 / X3)
      A2 = Y3 / (X3 * * B2)
      A = (((F * F - F1 * F1) * (A2 - A1)) / (F2 * F2 - F1 * F1)) + A1
      B = ((F2 - F) / (F2 - F1)) * B1 + ((F - F1) / (F2 - F1)) * B2
      GO TO 165
160   A = 0.000973 * F * F
      B = 1.0
165   IF (F .LT. 1.29) GO TO 210
      IF (F .LT. 2.8) GO TO 170
      IF (F .LT. 8.0) GO TO 175
      IF (F .LT. 9.35) GO TO 180
      IF (F .LT. 15.5) GO TO 185
      IF (F .LT. 35.0) GO TO 190
      IF (F .LT. 70.0) GO TO 195
      IF (F .LT. 94.0) GO TO 200
170   Y1 = 530.0
      Y2 = 2.1E+4
      Y3 = 600.0
      Y4 = 2.3E+4
      F1 = 1.29
      F2 = 2.80
      GO TO 205
175   Y1 = 600.0
      Y2 = 2.3E+4
      Y3 = 690.0
      Y4 = 2.5E+4
      F1 = 2.8
      F2 = 8.0
      GO TO 205
180   Y1 = 690.0
      Y2 = 2.5E+4
      Y3 = 610.0
      Y4 = 2.1E+4
      F1 = 8.0
      F2 = 9.35
      GO TO 205
185   Y1 = 610.0
      Y2 = 2.1E+4
      Y3 = 1000.0
      Y4 = 3.3E+4
      F1 = 9.35
      F2 = 15.5
      GO TO 205
190   Y1 = 1000.0
      Y2 = 3.3E+4
      Y3 = 890.0
      Y4 = 1.2E+4
      F1 = 15.5
```

```
      F2 = 35.0
      GO TO 205
195   Y1 = 890.0
      Y2 = 1.2E+4
      Y3 = 170.0
      Y4 = 910.0
      F1 = 35.0
      F2 = 70.0
      GO TO 205
200   Y1 = 170.0
      Y2 = 910.0
      Y3 = 51.0
      Y4 = 260.0
      F1 = 70.0
      F2 = 94.0
205   D1 = ALOG (Y2 / Y1) / ALOG (X2 / X1)
      C1 = Y1 / (X1 * * D1)
      D2 = ALOG (Y4 / Y3) / ALOG (X4 / X3)
      C2 = Y3 / (X3 * * D2)
      C = (((F * F - F1 * F1) * (C2 - C1)) / (F2 * F2 - F1 * F1)) + C1
      D = ((F2 - F) / (F2 - F1)) * D1 + ((F - F1) / (F2 - F1)) * D2
      GO TO 220
 210  WRITE(6,1500)
1500  FORMAT(48H FREQUENCY TOO LOW FOR REFLECTIVITY IN SUB CRANE)
1502  FORMAT(32H FREQUENCY TOO HIGH IN SUB CRANE)
220   RETURN
      END
```

```
      FUNCTION TERP (N, P, X, Y)
C
C      THIS FUNCTION DOES LINEAR INTERPOLATION AND EXTRAPOLATION.
C     N=NUMBER OF DATA POINTS (X,Y) TO BE USED IN INTERPOLATION.
C     P= X VALUE THAT PRODUCES INTERPOLATED Y VALUE.
C
      DIMENSION X(75),Y(75)
      IF (N .LT. 2) GO TO 240
      DO 225 I = 2, N
      IF (P - X (I))230, 235, 225
 225  CONTINUE
 240  CONTINUE
      I = N
 230  TERP = Y (I - 1) + (Y (I) - Y (I - 1)) * (P - X (I - 1)) / (X (I)
     1- X (I - 1))
      RETURN
 235  TERP = Y (I)
      RETURN
      END
```

```
      SUBROUTINE TOPOXY(T,P,PLAMDA,L,GAMAU,ARROW,GAMAUP)
C     THIS SUBROUTINE CALCULATES ATMOSPHERIC ABSORPTION PER UNIT LENGTH
C     DUE TO ATMOSPHERIC OXYGEN FOR FREQUENCIES ROUGHLY IN THE RANGE
C     45-70 GHZ. SEE, AS AN EXAMPLE, FALCONE, V.J., ATMOSPHERIC
C     ATTENUATION OF MICROWAVE POWER, J. MICROWAVE POWER (CANADA), VOL.5
C     NO. 4, DEC. 1970, PP. 269-278.
C
C                 INPUT
C
C     T=TEMPERATURE IN DEGREES KELVIN.
C     P=PRESSURE IN MILLIBARS.
C     PLAMDA=WAVELENGTH IN CENTIMETERS.
C     L=ACCOUNTED FOR BY TEST30.
C     ARROW=ATMOSPHERIC WATER VAPOR DENSITY ON TRANSMISSION PATH OF
C     INTEREST.
C
C                 OUTPUT
C
C     GAMAU=OXYGEN ABSORPTION COEFFICIENT IN DB/KM.
C     GAMAUP=PHASE DISPERSION DUE TO OXYGEN IN RADIANS/KM.
C
      COMMON /BLOCK2 /PMUPL (49), PMUM (49), PMUNOT (49), RSRLN1 (49), R
     1SRLN2 (49)
      REAL L3
C
      VP = T * ARROW / 216.68
      GOTO(100,105),L
  100 X1 = .021333
      X2 = .04523
      X3 = .36748
      X4 = .027351
      X5 = 1.
      L3 = ALOG (X3)
      DXDLOG = (X2 - X1) / (ALOG (X4) - L3)
  105 RLMDA = 1.0 / PLAMDA
      BB = 2.068666098 / T
      SUM = 0.0
      SUMP = 0.0
      FEE = 0.0
      NN = 49
      X = (P + VP) / 1013.25
      IF (X .GT. X3) GO TO 110
      IF (X .LT. X4) GO TO 115
      DLT2=X1+DXDLOG*(ALOG(X)-L3)
      DLT1=DLT2
      GO TO 120
  110 DLT2=X1
      DLT1=X1
      GO TO 120
  115 DLT1=X2
      DLT2=X2
      GO TO 120
  120 DLT1 = DLT1 * ((300. / T) * * X5) * X
      DLT2 = DLT2 * ((300. / T) * * X5) * X
      DLTNUA = 0.5 * (DLT1 + DLT2)
      GOTO(125,135),L
  125 IF (NN .LT. 1) GO TO 145
      DO 130 K = 1, NN, 2
      PK = K
      PMUPL (K) = PK * (2. * PK + 3.) / (PK + 1.)
```

```
      PMUM (K) = (PK + 1.) * (2. * PK - 1.) / PK
      PMUNOT (K) = (PK * PK + PK + 1.0) / (PK * (PK + 1.0))
  130 PMUNOT (K) = PMUNOT (K) * (2. * PK + 1.) * 2.
  145 CONTINUE
      CALL FREQ
  135 IF (NN .LT. 1) GO TO 150
      DO 140 K = 1, NN, 2
      PK = K
      FAC = EXP ( - BB * PK * (PK + 1.))
      CALL FARM (DLT1, RSRLN1 (K), RLMDA, AA, AAP)
      CALL FARM (DLT2, RSRLN2 (K), RLMDA, AB, ABP)
      CALL FARM (DLTNUA, FFE, RLMDA, AC, ACP)
      AC = AC * 0.5
      TERM = (AA * PMUPL (K) + AB * PMUM (K) + AC * PMUNOT (K)) * FAC
      TERMP = (AAP * PMUPL (K) + ABP * PMUM (K) + ACP * PMUNOT (K)) * FA
     1C
      SUM = SUM + TERM
      SUMP = SUMP + TERMP
  140 CONTINUE
  150 CONTINUE
      GAMAU = SUM * 59.4681828 * P / (T * T * T)
      GAMAU = GAMAU / (PLAMDA * PLAMDA)
      GAMAUP = SUMP * 6.846527564 * P / (T * T * T)
      GAMAUP = GAMAUP / (PLAMDA * PLAMDA)
      RETURN
      END




      SUBROUTINE FREQ
C
C     THIS SUBROUTINE IS ASSOCIATED WITH SUBROUTINE TOPOXY, BUT IS NOT
C     DIRECTLY ASSOCIATED WITH ANY OF THE PARAMETERS USED IN PREDIC.
C
      COMMON /BLOCK2 /PMUPL (49), PMUM (49), PMUNOT (49), RSRLM1 (49), R
     1SRLM2 (49)
      PMU = - 252.72
  100 DO 125 K = 1, 49, 2
      PK = K
      IF (K - 1)105, 110, 115
  105 STOP
  110 FUDGE = - 1.0
      GO TO 120
  115 FUDGE = 1.0
  120 CONTINUE
      PLAMDA = 59501.6 + .0575 * PK * (PK + 1.0)
      B = 43101.6 - .14 * PK * (PK + 1.0)
      RSRLM1 (K) = RSLMD1 (PK, PLAMDA, B, PMU)
      RSRLM2 (K) = RSLMD2 (PK, PLAMDA, B, PMU, FUDGE)
  125 CONTINUE
      RETURN
      END
```

```
      FUNCTION RSLMD1 (PK, PLAMDA, B, PMU)
C
C     THIS SUBROUTINE IS ASSOCIATED WITH SUBROUTINE TOPOXY, BUT IS NOT
C     DIRECTLY ASSOCIATED WITH ANY OF THE PARAMETERS USED IN PREDIC.
C
      Y = B - PMU / 2.
      Y1 = (PK + PK + 3.) * Y
      X = PLAMDA - PMU * (PK + 1.) - Y1 + SQRT (PLAMDA * PLAMDA - (PLAMD
     1A + PLAMDA) * Y + Y1 * Y1)
      RSLMD1 = X / (2.99793E+4)
      RETURN
      END
```

```
      FUNCTION RSLMD2 (PK, PLAMDA, B, PMU, FUDGE)
C
C     THIS SUBROUTINE IS ASSOCIATED WITH SUBROUTINE TOPOXY, BUT IS NOT
C     DIRECTLY ASSOCIATED WITH ANY OF THE PARAMETERS USED IN PREDIC.
C
      Y = B - PMU / 2.
      Y1 = (PK + PK - 1.) * Y
      X = PLAMDA + PMU * PK + Y1 - FUDGE * SQRT (PLAMDA * PLAMDA - (PLAM
     1DA + PLAMDA) * Y + Y1 * Y1)
      RSLMD2 = X / (2.99793E+4)
      RETURN
      END
```

```
      SUBROUTINE FARM (DLTN, RESWAV, ACTWAV, FORMA, FORMP)
C
C     THIS SUBROUTINE IS ASSOCIATED WITH SUBROUTINE TOPOXY, BUT IS NOT
C     DIRECTLY ASSOCIATED WITH ANY OF THE PARAMETERS USED IN PREDIC.
C
      X = RESWAV - ACTWAV
      X2 = X * X
      Y = RESWAV + ACTWAV
      Y2 = Y * Y
      D2 = DLTN * DLTN
      FORM1 = X2 + D2
      FORM1 = 1. / FORM1
      FORM2 = Y2 + D2
      FORM2 = 1. / FORM2
      FORMA = DLTN * (FORM1 + FORM2)
      FORMP=(D2/ACTWAV+(RESWAV/ACTWAV)*X)*FORM1+(D2/ACTWAV+(RESWAV/ACTWA
     1V)*Y)*FORM2
      RETURN
      END
```

```
      SUBROUTINE PROMO   (WAVE,D,N)
C
C. . .THIS SUBROUTINE PERFORMS THE MODIFICATION OF ATTENUATION OF MICRO-
C     WAVE TERRESTRIAL LINKS FOR METHODS 1 AND 2, DESCRIBED IN THE MAIN
C     PROGRAM.
C
C     INPUT
C
C     WAVE - CARRIER WAVELENGTH IN CM.
C        D - PATH LENGTH IN KM.
C        N - INTEGER CORRESPONDING TO METHOD 1 OR 2.
C
      DIMENSION W(6),CA(6),BB(6),RELIS(15),RELIT(15),RELY(15),ETA(15)
      DIMENSION EMTAU(15)
      COMMON/FROM/TAUDBT(15),REVTAU(15),RELI(15),HTOP(12)
      F=29.9793/WAVE
      RFSQ=F*F/225.0
      DO 10 I=1,12
      RELY(I)=RELI(I)
      IF(N.EQ.1) EMTAU(I)=(RFSQ*0.987/TAUDBT(I))*(SQRT(16994.70663*HTOP(
     1I))/D)
      IF(N.EQ.2) EMTAU(I)=(RFSQ*0.987/TAUDBT(I))*(SQRT(16994.70663*HTOP(
     1I))/D)**2.0
      RELIT(I)=RELY(I)*EMTAU(I)
   10 CONTINUE
      DO 20 I=1,12
      IF(RELIT(I).GE.RELY(I)) 6,8
    6 EMTAU(I)=1.0
      REVTAU(I)=TAUDBT(I)
      GO TO 20
    8 REVTAU(I)=EXTERP(12,RELY(I),RELIT,TAUDBT)
   20 CONTINUE
      RETURN
      END
```

```
      FUNCTION EXTERP(N,P,X,Y)
C
C     THIS FUNCTION PERFORMS EXPONENTIAL INTERPOLATION AND EXTRAPOLATION
C     ON Y VALUES, GIVEN X VALUES.
C
C     INPUT
C
C     N - NUMBER OF DATA POINTS.
C     P - POINT ON X-COORDINATE NEEDING A CORRESPONDING Y INTERPOLATION.
C     X - ARRAY OF N X-COORDINATE DATA POINTS.
C     Y - ARRAY OF N Y-COORDINATE DATA POINTS.
C
      DIMENSION X(50),Y(50)
      DO 1 I=2,N
      IF (X(I)-P) 1,2,2
    1 CONTINUE
      I = N
    2 IF (Y(I)*Y(I-1)) 3,3,4
    3 EXTERP = (Y(I)-Y(I-1))*(P-X(I-1))/(X(I)-X(I-1))  + Y(I-1)
      RETURN
    4 EXTERP = Y(I-1)*EXP (ALOG(Y(I)/Y(I-1))*(P-X(I-1))/(X(I)-X(I-1)))
      RETURN
      END
```

```
      SUBROUTINE TABLES(XLAT,XLON,ELEV,PRES,TMP,RLHUM,BET,M)
C
C
C     TABLES FINDS THE CLOSEST 20 OF THE 249 SAMPLE DATA STATIONS
C     (DUTTON ET AL., 1974) TO AN INTENDEC INTERPOLATION POINT.  TABLES
C     THEN CALLS IDBVIP (AKIMA,1975) TO OBTAIN METEOROLOGICAL CONDITIONS
C     AT THE INTERPOLATION POINT.  FOR BEST RESULTS, THE INTERPOLATION
C     POINT SHOULD NOT BE OUTSIDE OF THESE LATITUDE AND LONGITUDE
C     BOUNDS (DD.MM) -- 52.00N TO 40.00N BY 1.20E TO 25.00E -- WHICH
C     CORRESPOND ROUGHLY TO THE LIMITS OF THE EWCS ZONE.  IF THE INTER-
C     POLATION POINT IS OUTSIDE THESE BOUNDS, A WARNING WILL BE PRINTED
C     BUT PROCESSING WILL CONTINUE.
C
C
C     INPUT ---
C
C     ELEV - ELEVATION OF THE INTERPOLATION POINT IN METERS.
C     XLAT - DEGREE-MINUTES (DD.MM) LATITUDE OF INTERPOLATICN POINT.
C     XLON - DEGREE-MINUTES (DD.MM) LONGITUDE OF INTERPOLATION POINT.
C
C
C     OUTPUT ---
C
C     BET - INTERPOLATED VALUE OF BETA (DIMENSIONLESS).
C     M - INTERPOLATED TOTAL ANNUAL PRECIPITATION (MILLIMETERS).
C     PRES - INTERPOLATED SURFACE PRESSURE (MILLIBARS).
C     RLHUM - INTERPOLATED RELATIVE HUMIDITY (DECIMAL FRACTION).
C     TMP - INTERPOLATED TEMPERATURE (DEGREES CENTIGRADE).
C
C
C     DESCRIPTION OF MAJOR VARIABLES ----
C
C     BETA - ARRAY CONTAINING THE BETAS OF THE 20 CLOSEST STATIONS.
C     DATAPT - ARRAY CONTAINING METEOROLOGICAL DATA FOR ALL 249 STATIONS
C              ARRAINGED BY COLUMNS - 1=PRESSURE, 2=TEMPERATURE, 3=
C              RELATIVE HUMIDITY, 4=BETA, 5=M.
C     DCXLAT - DECIMAL DEGREES OF XLAT.
C     DCXLON - DECIMAL DEGREES OF XLCN.
C     DECLAT - ARRAY CONTIANING DECIMAL LATITUDES OF 249 DATA STAIONS.
C     DECLON - ARRAY CONTAINING DECIMAL LONGITUDES OF 249 DATA STATIONS.
C     ELEV1 - ARRAY CONTAINING ELEVATIONS OF ALL 249 STATIONS.
C     ELV - VALUE OF ELEV ROUNDED TO THE NEAREST CONTOUR INTERVAL.
C     ISUB - ARRAY CONTAINING THE ARRAY SUBSCRIPTS OF THE 20 CLOSEST
C            STATIONS.
C     IWK - ARRAY INTERNAL TO IDBVIP WHICH MUST BE DIMENSIONED IN THE
C           CALLING PROGRAM (AKIMA, 1975).
C     LAT - ARRAY CONTAINING THE DEGREE-MINUTES (DD.MM) LATTITUDE OF 249
C           STATIONS.
C     LON - ARRAY CONTAINING THE DEGREE-MINUTES (DD.MM) LONGITUDE OF 249
C            STATIONS.
C     LATT - ARRAY CONTAINING THE DECIMAL LATITUDES OF THE 20 CLOSEST
C            STATIONS.
C     LONG - ARRAY CONTAINING THE DECIMAL LONGITUDES OF THE 20 CLOSEST
C            STATIONS.
C     MM - ARRAY CONTAINING M VALUES OF THE 20 CLOSEST STATIONS.
C     N - NUMBER OF STATIONS.
C     NCP - NUMBER OF ADDITIONAL POINTS FOR IDBVIP TO USE IN CALCULATION
C           (INTERNAL TO IDBVIP-POINTS NOT SUPPLIED SEPARATELY BY TABLES
C            ).
C     NDP - NUMBER OF CLOSEST STATIONS USED IN THE INTERPOLATION OF
```

```
C           PRESSURE, TEMPERATURE, RELATIVE HUMIDITY  AND BETA.
C        NDPM - NUMBER OF CLOSEST STATIONS USED IN INTERPOLATING M VALUES.
C        NIP - NUMBER OF POINTS TO INTERPOLATE AT.
C        PRESS - ARRAY CONTAINING PRESSURES OF THE 20 CLOSEST STATIONS.
C        RELHUM - ARRAY CONTAING REL. HUMIDITY OF THE 20 CLOSEST STATIONS.
C        TEMP - ARRAY CONTAINING THE TEMPERATURE OF THE 20 CLOSEST STATIONS
C        WK - ARRAY INTERNAL TO IDBVIP WHICH MUST BE DIMENSIONED IN THE
C           CALLING PROGRAM (AKIMA, 1975).
C
C        ****************************************************************
C
C
      DIMENSION ELEV1(249),PRESS(20),TEMP(20),RELHUM(20),BETA(20),
     1DECLAT(249),DECLON(249),WK(160),DATAPT(249,5),ISUB(20),PRS(249),
     2IWK(641)
      REAL LAT(249),LON(249),MM(20),LATT(20),LONG(20),M
C
C.....COMMON REQUIRED BY IDBVIP (AKIMA, 1975).
C
      COMMON/IDCM/NCP
C
C.....DATA STATEMENTS CONTAINING POSITION,ELEVATION AND METEOROLOGICAL
C.....DATA ON 249 STATIONS.
C
      DATA LAT(  1),LON(  1),ELEV1(  1)/ 68.58, 33.03,   46./
      DATA DATAPT(  1,1),DATAPT(  1,2),DATAPT(  1,3),DATAPT(  1,4),
     1DATAPT(  1,5)/1004.4,   .2, .78, .035, 384.0/
      DATA LAT(  2),LON(  2),ELEV1(  2)/ 68.39, 43.18,    0./
      DATA DATAPT(  2,1),DATAPT(  2,2),DATAPT(  2,3),DATAPT(  2,4),
     1DATAPT(  2,5)/1011.2, -1.5, .81, .036, 325.0/
      DATA LAT(  3),LON(  3),ELEV1(  3)/ 70.22, 31.06,   15./
      DATA DATAPT(  3,1),DATAPT(  3,2),DATAPT(  3,3),DATAPT(  3,4),
     1DATAPT(  3,5)/1007.4,  1.6, .85, .021, 545.0/
      DATA LAT(  4),LON(  4),ELEV1(  4)/ 60.08, -1.11,   82./
      DATA DATAPT(  4,1),DATAPT(  4,2),DATAPT(  4,3),DATAPT(  4,4),
     1DATAPT(  4,5)/1000.0,  7.2, .93, .034,1129.0/
      DATA LAT(  5),LON(  5),ELEV1(  5)/ 58.13, -6.20,    3./
      DATA DATAPT(  5,1),DATAPT(  5,2),DATAPT(  5,3),DATAPT(  5,4),
     1DATAPT(  5,5)/1010.0,  8.6, .89, .051,1041.0/
      DATA LAT(  6),LON(  6),ELEV1(  6)/ 56.30, -6.53,   10./
      DATA DATAPT(  6,1),DATAPT(  6,2),DATAPT(  6,3),DATAPT(  6,4),
     1DATAPT(  6,5)/1010.0,  9.8, .84, .030,1128.0/
      DATA LAT(  7),LON(  7),ELEV1(  7)/ 57.12, -2.12,   59./
      DATA DATAPT(  7,1),DATAPT(  7,2),DATAPT(  7,3),DATAPT(  7,4),
     1DATAPT(  7,5)/1004.6,  7.9, .87, .038, 837.0/
      DATA LAT(  8),LON(  8),ELEV1(  8)/ 55.57, -3.21,  242./
      DATA DATAPT(  8,1),DATAPT(  8,2),DATAPT(  8,3),DATAPT(  8,4),
     1DATAPT(  8,5)/1008.2,  7.7, .88, .040, 656.0/
      DATA LAT(  9),LON(  9),ELEV1(  9)/ 55.19, -3.12,   32./
      DATA DATAPT(  9,1),DATAPT(  9,2),DATAPT(  9,3),DATAPT(  9,4),
     1DATAPT(  9,5)/ 983.7,  7.1, .89, .045,1527.0/
      DATA LAT( 10),LON( 10),ELEV1( 10)/ 54.18, -1.32,   68./
      DATA DATAPT( 10,1),DATAPT( 10,2),DATAPT( 10,3),DATAPT( 10,4),
     1DATAPT( 10,5)/1009.5,  8.0, .89, .070, 645.0/
      DATA LAT( 11),LON( 11),ELEV1( 11)/ 54.39, -6.13,   35./
      DATA DATAPT( 11,1),DATAPT( 11,2),DATAPT( 11,3),DATAPT( 11,4),
     1DATAPT( 11,5)/1003.7,  9.3, .84, .025, 846.0/
      DATA LAT( 12),LON( 12),ELEV1( 12)/ 53.15, -4.32,  -10./
      DATA DATAPT( 12,1),DATAPT( 12,2),DATAPT( 12,3),DATAPT( 12,4),
     1DATAPT( 12,5)/1013.1,  9.2, .83, .050, 862.0/
```

```
 DATA LAT( 13),LON( 13),ELEV1( 13)/ 53.21, -2.16,  75./
 DATA DATAPT( 13,1),DATAPT( 13,2),DATAPT( 13,3),DATAPT( 13,4),
1DATAPT( 13,5)/1004.8,  9.5, .85, .079, 799.0/
 DATA LAT( 14),LON( 14),ELEV1( 14)/ 52.27, -1.45,  97./
 DATA DATAPT( 14,1),DATAPT( 14,2),DATAPT( 14,3),DATAPT( 14,4),
1DATAPT( 14,5)/1003.0,  9.7, .84, .070, 727.0/
 DATA LAT( 15),LON( 15),ELEV1( 15)/ 53.10,  -.31,  68./
 DATA DATAPT( 15,1),DATAPT( 15,2),DATAPT( 15,3),DATAPT( 15,4),
1DATAPT( 15,5)/1006.0,  9.4, .87, .045, 597.0/
 DATA LAT( 16),LON( 16),ELEV1( 16)/ 52.35,  1.43,   4./
 DATA DATAPT( 16,1),DATAPT( 16,2),DATAPT( 16,3),DATAPT( 16,4),
1DATAPT( 16,5)/1014.3,  9.9, .84, .060, 583.0/
 DATA LAT( 17),LON( 17),ELEV1( 17)/ 51.28,  -.19,   5./
 DATA DATAPT( 17,1),DATAPT( 17,2),DATAPT( 17,3),DATAPT( 17,4),
1DATAPT( 17,5)/1014.7, 10.5, .81, .069, 594.0/
 DATA LAT( 18),LON( 18),ELEV1( 18)/ 51.09,  -.11,  60./
 DATA DATAPT( 18,1),DATAPT( 18,2),DATAPT( 18,3),DATAPT( 18,4),
1DATAPT( 18,5)/1008.1, 10.3, .81, .070, 683.0/
 DATA LAT( 19),LON( 19),ELEV1( 19)/ 51.24, -3.21,  67./
 DATA DATAPT( 19,1),DATAPT( 19,2),DATAPT( 19,3),DATAPT( 19,4),
1DATAPT( 19,5)/1006.7, 10.2, .81, .060,1100.0/
 DATA LAT( 20),LON( 20),ELEV1( 20)/ 50.47, -1.50,  11./
 DATA DATAPT( 20,1),DATAPT( 20,2),DATAPT( 20,3),DATAPT( 20,4),
1DATAPT( 20,5)/1014.3,  9.9, .81, .070, 800.0/
 DATA LAT( 21),LON( 21),ELEV1( 21)/ 50.21, -4.07,  27./
 DATA DATAPT( 21,1),DATAPT( 21,2),DATAPT( 21,3),DATAPT( 21,4),
1DATAPT( 21,5)/1012.2, 10.8, .87, .068, 990.0/
 DATA LAT( 22),LON( 22),ELEV1( 22)/ 55.22, -7.20,  25./
 DATA DATAPT( 22,1),DATAPT( 22,2),DATAPT( 22,3),DATAPT( 22,4),
1DATAPT( 22,5)/1008.9,  9.5, .83, .025, 980.0/
 DATA LAT( 23),LON( 23),ELEV1( 23)/ 54.14,-10.00,  10./
 DATA DATAPT( 23,1),DATAPT( 23,2),DATAPT( 23,3),DATAPT( 23,4),
1DATAPT( 23,5)/1011.2, 10.0, .84, .040,1133.0/
 DATA LAT( 24),LON( 24),ELEV1( 24)/ 53.26, -6.15,  81./
 DATA DATAPT( 24,1),DATAPT( 24,2),DATAPT( 24,3),DATAPT( 24,4),
1DATAPT( 24,5)/1003.5,  9.6, .83, .035, 758.0/
 DATA LAT( 25),LON( 25),ELEV1( 25)/ 52.41, -8.55,   7./
 DATA DATAPT( 25,1),DATAPT( 25,2),DATAPT( 25,3),DATAPT( 25,4),
1DATAPT( 25,5)/1012.8, 10.2, .86, .062, 930.0/
 DATA LAT( 26),LON( 26),ELEV1( 26)/ 51.51, -8.30, 162./
 DATA DATAPT( 26,1),DATAPT( 26,2),DATAPT( 26,3),DATAPT( 26,4),
1DATAPT( 26,5)/ 994.4, 10.2, .83, .055,1049.0/
 DATA LAT( 27),LON( 27),ELEV1( 27)/ 51.56,-10.15,  14./
 DATA DATAPT( 27,1),DATAPT( 27,2),DATAPT( 27,3),DATAPT( 27,4),
1DATAPT( 27,5)/1012.5, 10.8, .93, .076,1398.0/
 DATA LAT( 28),LON( 28),ELEV1( 28)/ 57.06,  9.52,   3./
 DATA DATAPT( 28,1),DATAPT( 28,2),DATAPT( 28,3),DATAPT( 28,4),
1DATAPT( 28,5)/1012.3,  7.6, .83, .036, 576.0/
 DATA LAT( 29),LON( 29),ELEV1( 29)/ 55.41, 12.33,   5./
 DATA DATAPT( 29,1),DATAPT( 29,2),DATAPT( 29,3),DATAPT( 29,4),
1DATAPT( 29,5)/1013.1,  8.5, .79, .048, 602.0/
 DATA LAT( 30),LON( 30),ELEV1( 30)/ 55.00, 15.05,   6./
 DATA DATAPT( 30,1),DATAPT( 30,2),DATAPT( 30,3),DATAPT( 30,4),
1DATAPT( 30,5)/1013.4,  8.0, .84, .033, 553.0/
 DATA LAT( 31),LON( 31),ELEV1( 31)/ 63.42,  9.37,   7./
 DATA DATAPT( 31,1),DATAPT( 31,2),DATAPT( 31,3),DATAPT( 31,4),
1DATAPT( 31,5)/1009.3,  5.9, .82, .055, 999.0/
 DATA LAT( 32),LON( 32),ELEV1( 32)/ 63.25, 10.26, 115./
 DATA DATAPT( 32,1),DATAPT( 32,2),DATAPT( 32,3),DATAPT( 32,4),
1DATAPT( 32,5)/ 996.9,  4.9, .78, .045, 857.0/
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 DATA LAT( 33),LON( 33),ELEV1( 33)/ 60.24,  5.19,  44./
 DATA DATAPT( 33,1),DATAPT( 33,2),DATAPT( 33,3),DATAPT( 33,4),
1DATAPT( 33,5)/1006.4,  7.8, .82, .134,1958.0/
 DATA LAT( 34),LON( 34),ELEV1( 34)/ 58.53,  5.38,   8./
 DATA DATAPT( 34,1),DATAPT( 34,2),DATAPT( 34,3),DATAPT( 34,4),
1DATAPT( 34,5)/1011.1,  7.4, .83, .140,1016.0/
 DATA LAT( 35),LON( 35),ELEV1( 35)/ 49.39, -1.28, 138./
 DATA DATAPT( 35,1),DATAPT( 35,2),DATAPT( 35,3),DATAPT( 35,4),
1DATAPT( 35,5)/ 999.6, 11.3, .82, .078, 931.0/
 DATA LAT( 36),LON( 36),ELEV1( 36)/ 48.27, -4.25, 103./
 DATA DATAPT( 36,1),DATAPT( 36,2),DATAPT( 36,3),DATAPT( 36,4),
1DATAPT( 36,5)/1003.8, 10.8, .86, .065,1126.0/
 DATA LAT( 37),LON( 37),ELEV1( 37)/ 47.10, -1.37,  27./
 DATA DATAPT( 37,1),DATAPT( 37,2),DATAPT( 37,3),DATAPT( 37,4),
1DATAPT( 37,5)/1014.1, 11.7, .83, .068, 782.0/
 DATA LAT( 38),LON( 38),ELEV1( 38)/ 48.58,  2.27,  65./
 DATA DATAPT( 38,1),DATAPT( 38,2),DATAPT( 38,3),DATAPT( 38,4),
1DATAPT( 38,5)/1008.6, 10.9, .78, .092, 585.0/
 DATA LAT( 39),LON( 39),ELEV1( 39)/ 48.41,  6.13, 217./
 DATA DATAPT( 39,1),DATAPT( 39,2),DATAPT( 39,3),DATAPT( 39,4),
1DATAPT( 39,5)/ 990.5,  9.5, .82, .091, 712.0/
 DATA LAT( 40),LON( 40),ELEV1( 40)/ 48.33,  7.38, 154./
 DATA DATAPT( 40,1),DATAPT( 40,2),DATAPT( 40,3),DATAPT( 40,4),
1DATAPT( 40,5)/ 998.7,  9.7, .80, .098, 607.0/
 DATA LAT( 41),LON( 41),ELEV1( 41)/ 47.16,  5.05, 227./
 DATA DATAPT( 41,1),DATAPT( 41,2),DATAPT( 41,3),DATAPT( 41,4),
1DATAPT( 41,5)/ 990.1, 10.5, .77, .099, 772.0/
 DATA LAT( 42),LON( 42),ELEV1( 42)/ 47.04,  2.22, 166./
 DATA DATAPT( 42,1),DATAPT( 42,2),DATAPT( 42,3),DATAPT( 42,4),
1DATAPT( 42,5)/ 996.7, 11.1, .78, .089, 671.0/
 DATA LAT( 43),LON( 43),ELEV1( 43)/ 45.49,  1.17, 396./
 DATA DATAPT( 43,1),DATAPT( 43,2),DATAPT( 43,3),DATAPT( 43,4),
1DATAPT( 43,5)/ 983.3, 10.6, .78, .047, 932.0/
 DATA LAT( 44),LON( 44),ELEV1( 44)/ 44.50,  -.42,  51./
 DATA DATAPT( 44,1),DATAPT( 44,2),DATAPT( 44,3),DATAPT( 44,4),
1DATAPT( 44,5)/1011.2, 12.3, .81, .114, 901.0/
 DATA LAT( 45),LON( 45),ELEV1( 45)/ 43.38,  1.22, 153./
 DATA DATAPT( 45,1),DATAPT( 45,2),DATAPT( 45,3),DATAPT( 45,4),
1DATAPT( 45,5)/ 999.1, 12.5, .78, .140, 659.0/
 DATA LAT( 46),LON( 46),ELEV1( 46)/ 50.48,  4.21, 104./
 DATA DATAPT( 46,1),DATAPT( 46,2),DATAPT( 46,3),DATAPT( 46,4),
1DATAPT( 46,5)/1003.0,  9.9, .83, .060, 785.0/
 DATA LAT( 47),LON( 47),ELEV1( 47)/ 52.06,  5.11,  -0./
 DATA DATAPT( 47,1),DATAPT( 47,2),DATAPT( 47,3),DATAPT( 47,4),
1DATAPT( 47,5)/1015.3,  9.3, .83, .123, 767.0/
 DATA LAT( 48),LON( 48),ELEV1( 48)/ 49.37,  6.03, 378./
 DATA DATAPT( 48,1),DATAPT( 48,2),DATAPT( 48,3),DATAPT( 48,4),
1DATAPT( 48,5)/ 975.5,  8.8, .81, .070, 740.0/
 DATA LAT( 49),LON( 49),ELEV1( 49)/ 54.32,  9.33,  48./
 DATA DATAPT( 49,1),DATAPT( 49,2),DATAPT( 49,3),DATAPT( 49,4),
1DATAPT( 49,5)/1007.9,  8.2, .85, .082, 925.0/
 DATA LAT( 50),LON( 50),ELEV1( 50)/ 53.38, 10.00,  16./
 DATA DATAPT( 50,1),DATAPT( 50,2),DATAPT( 50,3),DATAPT( 50,4),
1DATAPT( 50,5)/1012.7,  8.6, .84, .136, 716.0/
 DATA LAT( 51),LON( 51),ELEV1( 51)/ 53.22,  7.13,  12./
 DATA DATAPT( 51,1),DATAPT( 51,2),DATAPT( 51,3),DATAPT( 51,4),
1DATAPT( 51,5)/1014.6,  8.8, .86, .092, 767.0/
 DATA LAT( 52),LON( 52),ELEV1( 52)/ 52.27,  9.43,  54./
 DATA DATAPT( 52,1),DATAPT( 52,2),DATAPT( 52,3),DATAPT( 52,4),
1DATAPT( 52,5)/1008.7,  8.9, .82, .091, 665.0/
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 DATA LAT( 53),LON( 53),ELEV1( 53)/ 51.19,  9.29, 163./
 DATA DATAPT( 53,1),DATAPT( 53,2),DATAPT( 53,3),DATAPT( 53,4),
1DATAPT( 53,5)/ 996.3,  9.0, .78, .106, 628.0/
 DATA LAT( 54),LON( 54),ELEV1( 54)/ 51.24,  6.58, 161./
 DATA DATAPT( 54,1),DATAPT( 54,2),DATAPT( 54,3),DATAPT( 54,4),
1DATAPT( 54,5)/ 995.7,  9.6, .80, .112, 882.0/
 DATA LAT( 55),LON( 55),ELEV1( 55)/ 48.50,  9.12, 315./
 DATA DATAPT( 55,1),DATAPT( 55,2),DATAPT( 55,3),DATAPT( 55,4),
1DATAPT( 55,5)/ 979.4,  9.5, .75, .113, 687.0/
 DATA LAT( 56),LON( 56),ELEV1( 56)/ 54.11, 12.05,  10./
 DATA DATAPT( 56,1),DATAPT( 56,2),DATAPT( 56,3),DATAPT( 56,4),
1DATAPT( 56,5)/1013.3,  8.5, .83, .092, 595.0/
 DATA LAT( 57),LON( 57),ELEV1( 57)/ 43.22, -8.25,  67./
 DATA DATAPT( 57,1),DATAPT( 57,2),DATAPT( 57,3),DATAPT( 57,4),
1DATAPT( 57,5)/1010.1, 13.9, .79, .267, 984.0/
 DATA LAT( 58),LON( 58),ELEV1( 58)/ 69.41, 18.55,  10./
 DATA DATAPT( 58,1),DATAPT( 58,2),DATAPT( 58,3),DATAPT( 58,4),
1DATAPT( 58,5)/1007.7,  3.3, .80, .045,1019.0/
 DATA LAT( 59),LON( 59),ELEV1( 59)/ 67.17, 14.25,  13./
 DATA DATAPT( 59,1),DATAPT( 59,2),DATAPT( 59,3),DATAPT( 59,4),
1DATAPT( 59,5)/1007.7,  4.6, .78, .060,1027.0/
 DATA LAT( 60),LON( 60),ELEV1( 60)/ 68.27, 22.39, 327./
 DATA DATAPT( 60,1),DATAPT( 60,2),DATAPT( 60,3),DATAPT( 60,4),
1DATAPT( 60,5)/ 970.3, -1.5, .90, .027, 380.0/
 DATA LAT( 61),LON( 61),ELEV1( 61)/ 65.50, 24.09,   7./
 DATA DATAPT( 61,1),DATAPT( 61,2),DATAPT( 61,3),DATAPT( 61,4),
1DATAPT( 61,5)/1010.2, -1.6, .88, .033, 565.0/
 DATA LAT( 62),LON( 62),ELEV1( 62)/ 65.04, 17.10, 327./
 DATA DATAPT( 62,1),DATAPT( 62,2),DATAPT( 62,3),DATAPT( 62,4),
1DATAPT( 62,5)/ 971.2,   .7, .88, .034, 493.0/
 DATA LAT( 63),LON( 63),ELEV1( 63)/ 63.11, 14.30, 366./
 DATA DATAPT( 63,1),DATAPT( 63,2),DATAPT( 63,3),DATAPT( 63,4),
1DATAPT( 63,5)/ 967.3,  2.9, .84, .031, 532.0/
 DATA LAT( 64),LON( 64),ELEV1( 64)/ 62.38, 17.57,   8./
 DATA DATAPT( 64,1),DATAPT( 64,2),DATAPT( 64,3),DATAPT( 64,4),
1DATAPT( 64,5)/1010.7,  4.4, .82, .066, 667.0/
 DATA LAT( 65),LON( 65),ELEV1( 65)/ 67.22, 26.39, 180./
 DATA DATAPT( 65,1),DATAPT( 65,2),DATAPT( 65,3),DATAPT( 65,4),
1DATAPT( 65,5)/ 898.1,  -.4, .80, .041, 507.0/
 DATA LAT( 66),LON( 66),ELEV1( 66)/ 64.17, 27.41, 136./
 DATA DATAPT( 66,1),DATAPT( 66,2),DATAPT( 66,3),DATAPT( 66,4),
1DATAPT( 66,5)/ 995.0,  1.9, .79, .044, 564.0/
 DATA LAT( 67),LON( 67),ELEV1( 67)/ 62.24, 25.40, 145./
 DATA DATAPT( 67,1),DATAPT( 67,2),DATAPT( 67,3),DATAPT( 67,4),
1DATAPT( 67,5)/ 994.0,  2.8, .82, .067, 619.0/
 DATA LAT( 68),LON( 68),ELEV1( 68)/ 63.03, 21.46,   8./
 DATA DATAPT( 68,1),DATAPT( 68,2),DATAPT( 68,3),DATAPT( 68,4),
1DATAPT( 68,5)/1010.7,  3.5, .83, .064, 482.0/
 DATA LAT( 69),LON( 69),ELEV1( 69)/ 64.35, 40.30,  13./
 DATA DATAPT( 69,1),DATAPT( 69,2),DATAPT( 69,3),DATAPT( 69,4),
1DATAPT( 69,5)/1010.9,  1.4, .81, .046, 521.0/
 DATA LAT( 70),LON( 70),ELEV1( 70)/ 63.49, 30.49, 181./
 DATA DATAPT( 70,1),DATAPT( 70,2),DATAPT( 70,3),DATAPT( 70,4),
1DATAPT( 70,5)/ 989.7, -1.0, .79, .030, 500.0/
 DATA LAT( 71),LON( 71),ELEV1( 71)/ 61.01, 36.27,  59./
 DATA DATAPT( 71,1),DATAPT( 71,2),DATAPT( 71,3),DATAPT( 71,4),
1DATAPT( 71,5)/1006.3,  2.5, .79, .072, 510.0/
 DATA LAT( 72),LON( 72),ELEV1( 72)/ 59.56, 10.44,  96./
 DATA DATAPT( 72,1),DATAPT( 72,2),DATAPT( 72,3),DATAPT( 72,4),
1DATAPT( 72,5)/1000.8,  5.9, .77, .115, 760.0/
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DATA LAT( 73),LON( 73),ELEV1( 73)/ 59.21, 17.57,  22./
 DATA DATAPT( 73,1),DATAPT( 73,2),DATAPT( 73,3),DATAPT( 73,4),
1DATAPT( 73,5)/1011.3,  6.6, .82, .048, 545.0/
 DATA LAT( 74),LON( 74),ELEV1( 74)/ 59.22, 13.28,  55./
 DATA DATAPT( 74,1),DATAPT( 74,2),DATAPT( 74,3),DATAPT( 74,4),
1DATAPT( 74,5)/1006.2,  5.9, .83, .054, 546.0/
 DATA LAT( 75),LON( 75),ELEV1( 75)/ 57.46, 14.05, 232./
 DATA DATAPT( 75,1),DATAPT( 75,2),DATAPT( 75,3),DATAPT( 75,4),
1DATAPT( 75,5)/ 984.7,  6.2, .85, .048, 536.0/
 DATA LAT( 76),LON( 76),ELEV1( 76)/ 57.43, 11.47,   5./
 DATA DATAPT( 76,1),DATAPT( 76,2),DATAPT( 76,3),DATAPT( 76,4),
1DATAPT( 76,5)/1012.4,  7.6, .80, .052, 565.0/
 DATA LAT( 77),LON( 77),ELEV1( 77)/ 57.40, 18.21,  47./
 DATA DATAPT( 77,1),DATAPT( 77,2),DATAPT( 77,3),DATAPT( 77,4),
1DATAPT( 77,5)/1007.4,  7.1, .85, .039, 559.0/
 DATA LAT( 78),LON( 78),ELEV1( 78)/ 60.31, 22.16,  54./
 DATA DATAPT( 78,1),DATAPT( 78,2),DATAPT( 78,3),DATAPT( 78,4),
1DATAPT( 78,5)/1005.9,  4.6, .80, .043, 586.0/
 DATA LAT( 79),LON( 79),ELEV1( 79)/ 60.19, 24.58,  58./
 DATA DATAPT( 79,1),DATAPT( 79,2),DATAPT( 79,3),DATAPT( 79,4),
1DATAPT( 79,5)/1005.6,  4.4, .80, .057, 638.0/
 DATA LAT( 80),LON( 80),ELEV1( 80)/ 52.28, 13.24,  49./
 DATA DATAPT( 80,1),DATAPT( 80,2),DATAPT( 80,3),DATAPT( 80,4),
1DATAPT( 80,5)/1009.3,  9.5, .73, .109, 557.0/
 DATA LAT( 81),LON( 81),ELEV1( 81)/ 49.30, 11.05, 312./
 DATA DATAPT( 81,1),DATAPT( 81,2),DATAPT( 81,3),DATAPT( 81,4),
1DATAPT( 81,5)/ 978.6,  8.4, .78, .185, 623.0/
 DATA LAT( 82),LON( 82),ELEV1( 82)/ 48.08, 11.43, 529./
 DATA DATAPT( 82,1),DATAPT( 82,2),DATAPT( 82,3),DATAPT( 82,4),
1DATAPT( 82,5)/ 954.3,  7.9, .80, .271, 964.0/
 DATA LAT( 83),LON( 83),ELEV1( 83)/ 54.06, 13.27,   3./
 DATA DATAPT( 83,1),DATAPT( 83,2),DATAPT( 83,3),DATAPT( 83,4),
1DATAPT( 83,5)/1014.3,  8.3, .83, .060, 553.0/
 DATA LAT( 84),LON( 84),ELEV1( 84)/ 53.21, 13.05,  70./
 DATA DATAPT( 84,1),DATAPT( 84,2),DATAPT( 84,3),DATAPT( 84,4),
1DATAPT( 84,5)/ 951.6,  8.0, .80, .090, 571.0/
 DATA LAT( 85),LON( 85),ELEV1( 85)/ 52.13, 14.07,  99./
 DATA DATAPT( 85,1),DATAPT( 85,2),DATAPT( 85,3),DATAPT( 85,4),
1DATAPT( 85,5)/1002.7,  8.6, .78, .116, 543.0/
 DATA LAT( 86),LON( 86),ELEV1( 86)/ 52.06, 11.35,  85./
 DATA DATAPT( 86,1),DATAPT( 86,2),DATAPT( 86,3),DATAPT( 86,4),
1DATAPT( 86,5)/1005.3,  9.7, .77, .160, 515.0/
 DATA LAT( 87),LON( 87),ELEV1( 87)/ 51.51, 10.46, 240./
 DATA DATAPT( 87,1),DATAPT( 87,2),DATAPT( 87,3),DATAPT( 87,4),
1DATAPT( 87,5)/ 986.6,  8.5, .74, .089, 627.0/
 DATA LAT( 88),LON( 88),ELEV1( 88)/ 51.24, 12.24, 133./
 DATA DATAPT( 88,1),DATAPT( 88,2),DATAPT( 88,3),DATAPT( 88,4),
1DATAPT( 88,5)/ 999.5,  8.7, .79, .081, 549.0/
 DATA LAT( 89),LON( 89),ELEV1( 89)/ 51.10, 14.57, 238./
 DATA DATAPT( 89,1),DATAPT( 89,2),DATAPT( 89,3),DATAPT( 89,4),
1DATAPT( 89,5)/ 987.9,  8.0, .78, .159, 688.0/
 DATA LAT( 90),LON( 90),ELEV1( 90)/ 50.59, 10.58, 316./
 DATA DATAPT( 90,1),DATAPT( 90,2),DATAPT( 90,3),DATAPT( 90,4),
1DATAPT( 90,5)/ 978.5,  7.8, .80, .145, 532.0/
 DATA LAT( 91),LON( 91),ELEV1( 91)/ 50.34, 10.23, 456./
 DATA DATAPT( 91,1),DATAPT( 91,2),DATAPT( 91,3),DATAPT( 91,4),
1DATAPT( 91,5)/ 962.2,  7.9, .79, .175, 718.0/
 DATA LAT( 92),LON( 92),ELEV1( 92)/ 50.39, 10.09, 494./
 DATA DATAPT( 92,1),DATAPT( 92,2),DATAPT( 92,3),DATAPT( 92,4),
1DATAPT( 92,5)/ 957.7,  7.9, .79, .175, 718.0/
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 DATA LAT( 93),LON( 93),ELEV1( 93)/ 51.48, 10.37,1152./
 DATA DATAPT( 93,1),DATAPT( 93,2),DATAPT( 93,3),DATAPT( 93,4),
1DATAPT( 93,5)/ 882.1,  2.9, .88, .141,1422.0/
 DATA LAT( 94),LON( 94),ELEV1( 94)/ 50.26, 12.57,1215./
 DATA DATAPT( 94,1),DATAPT( 94,2),DATAPT( 94,3),DATAPT( 94,4),
1DATAPT( 94,5)/ 876.2,  2.8, .87, .087,1109.0/
 DATA LAT( 95),LON( 95),ELEV1( 95)/ 48.12, 15.38, 282./
 DATA DATAPT( 95,1),DATAPT( 95,2),DATAPT( 95,3),DATAPT( 95,4),
1DATAPT( 95,5)/ 983.7,  8.7, .77, .146, 741.0/
 DATA LAT( 96),LON( 96),ELEV1( 96)/ 48.15, 16.22, 212./
 DATA DATAPT( 96,1),DATAPT( 96,2),DATAPT( 96,3),DATAPT( 96,4),
1DATAPT( 96,5)/ 991.2,  9.8, .71, .171, 615.0/
 DATA LAT( 97),LON( 97),ELEV1( 97)/ 47.48, 13.00, 450./
 DATA DATAPT( 97,1),DATAPT( 97,2),DATAPT( 97,3),DATAPT( 97,4),
1DATAPT( 97,5)/ 963.2,  8.1, .77, .164,1278.0/
 DATA LAT( 98),LON( 98),ELEV1( 98)/ 47.00, 15.27, 347./
 DATA DATAPT( 98,1),DATAPT( 98,2),DATAPT( 98,3),DATAPT( 98,4),
1DATAPT( 98,5)/ 975.3,  8.3, .78, .158, 840.0/
 DATA LAT( 99),LON( 99),ELEV1( 99)/ 50.05, 12.24, 471./
 DATA DATAPT( 99,1),DATAPT( 99,2),DATAPT( 99,3),DATAPT( 99,4),
1DATAPT( 99,5)/ 959.7,  7.0, .81, .150, 540.0/
 DATA LAT(100),LON(100),ELEV1(100)/ 50.06, 14.17, 381./
 DATA DATAPT(100,1),DATAPT(100,2),DATAPT(100,3),DATAPT(100,4),
1DATAPT(100,5)/ 970.8,  7.9, .78, .160, 520.0/
 DATA LAT(101),LON(101),ELEV1(101)/ 49.47, 18.16, 253./
 DATA DATAPT(101,1),DATAPT(101,2),DATAPT(101,3),DATAPT(101,4),
1DATAPT(101,5)/ 985.7,  8.1, .79, .175, 659.0/
 DATA LAT(102),LON(102),ELEV1(102)/ 49.09, 16.42, 242./
 DATA DATAPT(102,1),DATAPT(102,2),DATAPT(102,3),DATAPT(102,4),
1DATAPT(102,5)/ 987.1,  8.8, .73, .186, 527.0/
 DATA LAT(103),LON(103),ELEV1(103)/ 53.55, 14.14,  10./
 DATA DATAPT(103,1),DATAPT(103,2),DATAPT(103,3),DATAPT(103,4),
1DATAPT(103,5)/1014.2,  8.3, .83, .060, 625.0/
 DATA LAT(104),LON(104),ELEV1(104)/ 53.24, 14.37,   7./
 DATA DATAPT(104,1),DATAPT(104,2),DATAPT(104,3),DATAPT(104,4),
1DATAPT(104,5)/1013.8,  8.3, .81, .080, 511.0/
 DATA LAT(105),LON(105),ELEV1(105)/ 54.12, 16.11,  34./
 DATA DATAPT(105,1),DATAPT(105,2),DATAPT(105,3),DATAPT(105,4),
1DATAPT(105,5)/1010.2,  7.5, .82, .065, 697.0/
 DATA LAT(106),LON(106),ELEV1(106)/ 54.31, 18.33,   5./
 DATA DATAPT(106,1),DATAPT(106,2),DATAPT(106,3),DATAPT(106,4),
1DATAPT(106,5)/1014.2,  7.7, .81, .092, 750.0/
 DATA LAT(107),LON(107),ELEV1(107)/ 54.23, 18.36,  12./
 DATA DATAPT(107,1),DATAPT(107,2),DATAPT(107,3),DATAPT(107,4),
1DATAPT(107,5)/1013.3,  7.7, .79, .116, 499.0/
 DATA LAT(108),LON(108),ELEV1(108)/ 52.25, 16.50,  92./
 DATA DATAPT(108,1),DATAPT(108,2),DATAPT(108,3),DATAPT(108,4),
1DATAPT(108,5)/1004.7,  8.0, .78, .120, 488.0/
 DATA LAT(109),LON(109),ELEV1(109)/ 52.09, 20.59, 107./
 DATA DATAPT(109,1),DATAPT(109,2),DATAPT(109,3),DATAPT(109,4),
1DATAPT(109,5)/1002.9,  7.8, .78, .175, 471.0/
 DATA LAT(110),LON(110),ELEV1(110)/ 53.06, 23.10, 151./
 DATA DATAPT(110,1),DATAPT(110,2),DATAPT(110,3),DATAPT(110,4),
1DATAPT(110,5)/ 997.2,  6.8, .80, .165, 560.0/
 DATA LAT(111),LON(111),ELEV1(111)/ 51.06, 16.23, 124./
 DATA DATAPT(111,1),DATAPT(111,2),DATAPT(111,3),DATAPT(111,4),
1DATAPT(111,5)/1001.0,  8.3, .78, .168, 557.0/
 DATA LAT(112),LON(112),ELEV1(112)/ 51.03, 17.21, 134./
 DATA DATAPT(112,1),DATAPT(112,2),DATAPT(112,3),DATAPT(112,4),
1DATAPT(112,5)/ 999.7,  8.0, .78, .175, 525.0/
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      DATA LAT(113),LON(113),ELEV1(113)/ 50.05, 19.48, 237./
      DATA DATAPT(113,1),DATAPT(113,2),DATAPT(113,3),DATAPT(113,4),
     1DATAPT(113,5)/ 987.5,  7.8, .80, .160, 575.0/
      DATA LAT(114),LON(114),ELEV1(114)/ 49.48, 22.46, 280./
      DATA DATAPT(114,1),DATAPT(114,2),DATAPT(114,3),DATAPT(114,4),
     1DATAPT(114,5)/ 982.7,  8.0, .77, .138, 643.0/
      DATA LAT(115),LON(115),ELEV1(115)/ 46.47, 23.34, 415./
      DATA DATAPT(115,1),DATAPT(115,2),DATAPT(115,3),DATAPT(115,4),
     1DATAPT(115,5)/ 966.3,  8.6, .74, .132, 587.0/
      DATA LAT(116),LON(116),ELEV1(116)/ 47.09, 24.31, 366./
      DATA DATAPT(116,1),DATAPT(116,2),DATAPT(116,3),DATAPT(116,4),
     1DATAPT(116,5)/ 971.3,  8.5, .75, .101, 684.0/
      DATA LAT(117),LON(117),ELEV1(117)/ 59.58, 30.18,   4./
      DATA DATAPT(117,1),DATAPT(117,2),DATAPT(117,3),DATAPT(117,4),
     1DATAPT(117,5)/1013.2,  4.6, .79, .069, 525.0/
      DATA LAT(118),LON(118),ELEV1(118)/ 59.25, 24.48,  44./
      DATA DATAPT(118,1),DATAPT(118,2),DATAPT(118,3),DATAPT(118,4),
     1DATAPT(118,5)/1007.6,  5.2, .81, .050, 568.0/
      DATA LAT(119),LON(119),ELEV1(119)/ 54.53, 23.53,  75./
      DATA DATAPT(119,1),DATAPT(119,2),DATAPT(119,3),DATAPT(119,4),
     1DATAPT(119,5)/1005.8,  6.0, .80, .150, 625.0/
      DATA LAT(120),LON(120),ELEV1(120)/ 53.52, 27.32, 234./
      DATA DATAPT(120,1),DATAPT(120,2),DATAPT(120,3),DATAPT(120,4),
     1DATAPT(120,5)/ 987.0,  5.3, .80, .172, 606.0/
      DATA LAT(121),LON(121),ELEV1(121)/ 56.23, 30.36,  98./
      DATA DATAPT(121,1),DATAPT(121,2),DATAPT(121,3),DATAPT(121,4),
     1DATAPT(121,5)/1003.2,  3.8, .81, .115, 438.0/
      DATA LAT(122),LON(122),ELEV1(122)/ 59.17, 39.52, 118./
      DATA DATAPT(122,1),DATAPT(122,2),DATAPT(122,3),DATAPT(122,4),
     1DATAPT(122,5)/1000.2,  2.6, .80, .110, 390.0/
      DATA LAT(123),LON(123),ELEV1(123)/ 58.39, 49.37, 164./
      DATA DATAPT(123,1),DATAPT(123,2),DATAPT(123,3),DATAPT(123,4),
     1DATAPT(123,5)/ 995.7,  1.8, .78, .154, 526.0/
      DATA LAT(124),LON(124),ELEV1(124)/ 55.45, 37.34, 156./
      DATA DATAPT(124,1),DATAPT(124,2),DATAPT(124,3),DATAPT(124,4),
     1DATAPT(124,5)/ 997.0,  4.4, .77, .210, 560.0/
      DATA LAT(125),LON(125),ELEV1(125)/ 55.47, 49.11,  64./
      DATA DATAPT(125,1),DATAPT(125,2),DATAPT(125,3),DATAPT(125,4),
     1DATAPT(125,5)/1009.5,  3.1, .75, .205, 435.0/
      DATA LAT(126),LON(126),ELEV1(126)/ 51.42, 39.10, 164./
      DATA DATAPT(126,1),DATAPT(126,2),DATAPT(126,3),DATAPT(126,4),
     1DATAPT(126,5)/ 997.1,  5.5, .73, .168, 550.0/
      DATA LAT(127),LON(127),ELEV1(127)/ 51.34, 46.02, 156./
      DATA DATAPT(127,1),DATAPT(127,2),DATAPT(127,3),DATAPT(127,4),
     1DATAPT(127,5)/ 998.2,  5.9, .75, .138, 391.0/
      DATA LAT(128),LON(128),ELEV1(128)/ 49.49, 23.57, 325./
      DATA DATAPT(128,1),DATAPT(128,2),DATAPT(128,3),DATAPT(128,4),
     1DATAPT(128,5)/ 977.2,  7.0, .80, .124, 655.0/
      DATA LAT(129),LON(129),ELEV1(129)/ 50.24, 30.27, 179./
      DATA DATAPT(129,1),DATAPT(129,2),DATAPT(129,3),DATAPT(129,4),
     1DATAPT(129,5)/ 995.2,  7.4, .76, .137, 615.0/
      DATA LAT(130),LON(130),ELEV1(130)/ 41.39,   .53, 233./
      DATA DATAPT(130,1),DATAPT(130,2),DATAPT(130,3),DATAPT(130,4),
     1DATAPT(130,5)/ 988.4, 14.9, .61, .158, 339.0/
      DATA LAT(131),LON(131),ELEV1(131)/ 36.50,  2.28,   7./
      DATA DATAPT(131,1),DATAPT(131,2),DATAPT(131,3),DATAPT(131,4),
     1DATAPT(131,5)/1015.9, 18.1, .73, .139, 227.0/
      DATA LAT(132),LON(132),ELEV1(132)/ 39.57, 32.53, 894./
      DATA DATAPT(132,1),DATAPT(132,2),DATAPT(132,3),DATAPT(132,4),
     1DATAPT(132,5)/ 911.7, 11.7, .60, .081, 446.0/
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 DATA LAT(133),LON(133),ELEV1(133)/ 38.43, 35.29,1054./
 DATA DATAPT(133,1),DATAPT(133,2),DATAPT(133,3),DATAPT(133,4),
1DATAPT(133,5)/ 891.0, 10.8, .64, .285, 352.0/
 DATA LAT(134),LON(134),ELEV1(134)/ 39.45, 37.01,1284./
 DATA DATAPT(134,1),DATAPT(134,2),DATAPT(134,3),DATAPT(134,4),
1DATAPT(134,5)/ 867.7,  8.4, .65, .250, 414.0/
 DATA LAT(135),LON(135),ELEV1(135)/ 39.44, 39.30,1215./
 DATA DATAPT(135,1),DATAPT(135,2),DATAPT(135,3),DATAPT(135,4),
1DATAPT(135,5)/ 881.7, 10.7, .59, .117, 363.0/
 DATA LAT(136),LON(136),ELEV1(136)/ 38.45, 30.32,1034./
 DATA DATAPT(136,1),DATAPT(136,2),DATAPT(136,3),DATAPT(136,4),
1DATAPT(136,5)/ 986.6, 11.2, .63, .066, 621.0/
 DATA LAT(137),LON(137),ELEV1(137)/ 37.45, 30.33, 997./
 DATA DATAPT(137,1),DATAPT(137,2),DATAPT(137,3),DATAPT(137,4),
1DATAPT(137,5)/ 900.5, 12.1, .62, .244, 617.0/
 DATA LAT(138),LON(138),ELEV1(138)/ 37.58, 32.33,1022./
 DATA DATAPT(138,1),DATAPT(138,2),DATAPT(138,3),DATAPT(138,4),
1DATAPT(138,5)/ 987.7, 11.5, .60, .078, 311.0/
 DATA LAT(139),LON(139),ELEV1(139)/ 37.08, 38.46, 547./
 DATA DATAPT(139,1),DATAPT(139,2),DATAPT(139,3),DATAPT(139,4),
1DATAPT(139,5)/ 946.3, 18.1, .48, .183, 464.0/
 DATA LAT(140),LON(140),ELEV1(140)/ 38.26, 38.05, 849./
 DATA DATAPT(140,1),DATAPT(140,2),DATAPT(140,3),DATAPT(140,4),
1DATAPT(140,5)/ 915.3, 13.3, .54, .058, 370.0/
 DATA LAT(141),LON(141),ELEV1(141)/ 37.53, 40.11, 677./
 DATA DATAPT(141,1),DATAPT(141,2),DATAPT(141,3),DATAPT(141,4),
1DATAPT(141,5)/ 932.3, 15.7, .52, .104, 489.0/
 DATA LAT(142),LON(142),ELEV1(142)/ 38.27, 43.19,1661./
 DATA DATAPT(142,1),DATAPT(142,2),DATAPT(142,3),DATAPT(142,4),
1DATAPT(142,5)/ 827.7,  8.9, .59, .040, 385.0/
 DATA LAT(143),LON(143),ELEV1(143)/ 39.55, 41.16,1869./
 DATA DATAPT(143,1),DATAPT(143,2),DATAPT(143,3),DATAPT(143,4),
1DATAPT(143,5)/ 806.7,  5.1, .61, .113, 460.0/
 DATA LAT(144),LON(144),ELEV1(144)/ 49.56, 36.17, 152./
 DATA DATAPT(144,1),DATAPT(144,2),DATAPT(144,3),DATAPT(144,4),
1DATAPT(144,5)/ 998.8,  7.1, .74, .110, 573.0/
 DATA LAT(145),LON(145),ELEV1(145)/ 46.29, 30.08,  64./
 DATA DATAPT(145,1),DATAPT(145,2),DATAPT(145,3),DATAPT(145,4),
1DATAPT(145,5)/1008.9,  9.9, .76, .100, 389.0/
 DATA LAT(146),LON(146),ELEV1(146)/ 45.01, 33.59, 205./
 DATA DATAPT(146,1),DATAPT(146,2),DATAPT(146,3),DATAPT(146,4),
1DATAPT(146,5)/ 990.6, 10.1, .74, .168, 519.0/
 DATA LAT(147),LON(147),ELEV1(147)/ 47.15, 39.49,  77./
 DATA DATAPT(147,1),DATAPT(147,2),DATAPT(147,3),DATAPT(147,4),
1DATAPT(147,5)/1007.6,  9.0, .72, .090, 487.0/
 DATA LAT(148),LON(148),ELEV1(148)/ 46.16, 48.02, -18./
 DATA DATAPT(148,1),DATAPT(148,2),DATAPT(148,3),DATAPT(148,4),
1DATAPT(148,5)/1019.6,  9.5, .79, .085, 179.0/
 DATA LAT(149),LON(149),ELEV1(149)/ 44.03, 43.02, 500./
 DATA DATAPT(149,1),DATAPT(149,2),DATAPT(149,3),DATAPT(149,4),
1DATAPT(149,5)/1017.6,  8.6, .76, .108, 482.0/
 DATA LAT(150),LON(150),ELEV1(150)/ 45.43,  4.57, 201./
 DATA DATAPT(150,1),DATAPT(150,2),DATAPT(150,3),DATAPT(150,4),
1DATAPT(150,5)/ 993.0, 11.4, .76, .178, 813.0/
 DATA LAT(151),LON(151),ELEV1(151)/ 41.41, 44.57, 490./
 DATA DATAPT(151,1),DATAPT(151,2),DATAPT(151,3),DATAPT(151,4),
1DATAPT(151,5)/ 959.7, 12.9, .66, .145, 496.0/
 DATA LAT(152),LON(152),ELEV1(152)/ 47.15,  9.21,2500./
 DATA DATAPT(152,1),DATAPT(152,2),DATAPT(152,3),DATAPT(152,4),
1DATAPT(152,5)/ 748.7, -1.9, .77, .187,2478.0/
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 DATA LAT(153),LON(153),ELEV1(153)/ 47.23,  8.34, 569./
 DATA DATAPT(153,1),DATAPT(153,2),DATAPT(153,3),DATAPT(153,4),
1DATAPT(153,5)/ 949.6,  8.5, .76, .091,1071.0/
 DATA LAT(154),LON(154),ELEV1(154)/ 46.15,  6.07, 430./
 DATA DATAPT(154,1),DATAPT(154,2),DATAPT(154,3),DATAPT(154,4),
1DATAPT(154,5)/ 966.0, 10.3, .76, .126, 831.0/
 DATA LAT(155),LON(155),ELEV1(155)/ 46.49,  6.57, 491./
 DATA DATAPT(155,1),DATAPT(155,2),DATAPT(155,3),DATAPT(155,4),
1DATAPT(155,5)/ 959.3, 10.0, .78, .100, 978.0/
 DATA LAT(156),LON(156),ELEV1(156)/ 46.00,  8.58, 276./
 DATA DATAPT(156,1),DATAPT(156,2),DATAPT(156,3),DATAPT(156,4),
1DATAPT(156,5)/ 982.9, 11.7, .68, .188,1744.0/
 DATA LAT(157),LON(157),ELEV1(157)/ 47.39,  9.29, 407./
 DATA DATAPT(157,1),DATAPT(157,2),DATAPT(157,3),DATAPT(157,4),
1DATAPT(157,5)/ 968.7,  8.8, .82, .099, 960.0/
 DATA LAT(158),LON(158),ELEV1(158)/ 47.25, 10.59,2962./
 DATA DATAPT(158,1),DATAPT(158,2),DATAPT(158,3),DATAPT(158,4),
1DATAPT(158,5)/ 709.8, -4.7, .82, .150,1351.0/
 DATA LAT(159),LON(159),ELEV1(159)/ 47.16, 11.21, 598./
 DATA DATAPT(159,1),DATAPT(159,2),DATAPT(159,3),DATAPT(159,4),
1DATAPT(159,5)/ 946.0,  8.6, .72, .083, 899.0/
 DATA LAT(160),LON(160),ELEV1(160)/ 41.02, 40.30,   4./
 DATA DATAPT(160,1),DATAPT(160,2),DATAPT(160,3),DATAPT(160,4),
1DATAPT(160,5)/1016.2, 14.2, .78, .202,2441.0/
 DATA LAT(161),LON(161),ELEV1(161)/ 42.44,  2.52,  48./
 DATA DATAPT(161,1),DATAPT(161,2),DATAPT(161,3),DATAPT(161,4),
1DATAPT(161,5)/1010.3, 15.2, .67, .359, 639.0/
 DATA LAT(162),LON(162),ELEV1(162)/ 43.52,  4.24,  62./
 DATA DATAPT(162,1),DATAPT(162,2),DATAPT(162,3),DATAPT(162,4),
1DATAPT(162,5)/1008.6, 14.2, .66, .224, 743.0/
 DATA LAT(163),LON(163),ELEV1(163)/ 43.27,  5.13,   8./
 DATA DATAPT(163,1),DATAPT(163,2),DATAPT(163,3),DATAPT(163,4),
1DATAPT(163,5)/1014.6, 14.2, .71, .227, 550.0/
 DATA LAT(164),LON(164),ELEV1(164)/ 43.39,  7.12,  10./
 DATA DATAPT(164,1),DATAPT(164,2),DATAPT(164,3),DATAPT(164,4),
1DATAPT(164,5)/1013.3, 14.8, .76, .102, 862.0/
 DATA LAT(165),LON(165),ELEV1(165)/ 41.55,  8.18,   9./
 DATA DATAPT(165,1),DATAPT(165,2),DATAPT(165,3),DATAPT(165,4),
1DATAPT(165,5)/1013.9, 14.7, .79, .106, 681.0/
 DATA LAT(166),LON(166),ELEV1(166)/ 36.09, -5.21,   3./
 DATA DATAPT(166,1),DATAPT(166,2),DATAPT(166,3),DATAPT(166,4),
1DATAPT(166,5)/1017.0, 18.2, .74, .169, 815.0/
 DATA LAT(167),LON(167),ELEV1(167)/ 41.49, -6.46, 692./
 DATA DATAPT(167,1),DATAPT(167,2),DATAPT(167,3),DATAPT(167,4),
1DATAPT(167,5)/ 936.8, 11.6, .71, .199, 973.0/
 DATA LAT(168),LON(168),ELEV1(168)/ 41.14, -8.41,  73./
 DATA DATAPT(168,1),DATAPT(168,2),DATAPT(168,3),DATAPT(168,4),
1DATAPT(168,5)/1008.5, 14.4, .75, .195,1150.0/
 DATA LAT(169),LON(169),ELEV1(169)/ 40.12, -8.25, 140./
 DATA DATAPT(169,1),DATAPT(169,2),DATAPT(169,3),DATAPT(169,4),
1DATAPT(169,5)/1000.8, 15.9, .71, .234, 961.0/
 DATA LAT(170),LON(170),ELEV1(170)/ 38.46, -9.08, 110./
 DATA DATAPT(170,1),DATAPT(170,2),DATAPT(170,3),DATAPT(170,4),
1DATAPT(170,5)/1005.1, 16.6, .70, .074, 705.0/
 DATA LAT(171),LON(171),ELEV1(171)/ 38.01, -7.52, 247./
 DATA DATAPT(171,1),DATAPT(171,2),DATAPT(171,3),DATAPT(171,4),
1DATAPT(171,5)/ 987.7, 16.2, .64, .125, 549.0/
 DATA LAT(172),LON(172),ELEV1(172)/ 37.01, -7.58,   9./
 DATA DATAPT(172,1),DATAPT(172,2),DATAPT(172,3),DATAPT(172,4),
1DATAPT(172,5)/1015.3, 17.8, .72, .067, 455.0/
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 DATA LAT(173),LON(173),ELEV1(173)/ 41.39, -4.43, 715./
 DATA DATAPT(173,1),DATAPT(173,2),DATAPT(173,3),DATAPT(173,4),
1DATAPT(173,5)/ 933.8, 12.2, .64, .099, 409.0/
 DATA LAT(174),LON(174),ELEV1(174)/ 40.24, -3.41, 657./
 DATA DATAPT(174,1),DATAPT(174,2),DATAPT(174,3),DATAPT(174,4),
1DATAPT(174,5)/ 940.5, 13.9, .62, .128, 436.0/
 DATA LAT(175),LON(175),ELEV1(175)/ 38.53, -6.49, 192./
 DATA DATAPT(175,1),DATAPT(175,2),DATAPT(175,3),DATAPT(175,4),
1DATAPT(175,5)/ 994.6, 16.7, .61, .092, 474.0/
 DATA LAT(176),LON(176),ELEV1(176)/ 37.22, -6.00,  13./
 DATA DATAPT(176,1),DATAPT(176,2),DATAPT(176,3),DATAPT(176,4),
1DATAPT(176,5)/1016.0, 18.0, .68, .148, 559.0/
 DATA LAT(177),LON(177),ELEV1(177)/ 38.22,  -.30,  82./
 DATA DATAPT(177,1),DATAPT(177,2),DATAPT(177,3),DATAPT(177,4),
1DATAPT(177,5)/1007.2, 17.8, .66, .230, 302.0/
 DATA LAT(178),LON(178),ELEV1(178)/ 41.24,  2.09,  95./
 DATA DATAPT(178,1),DATAPT(178,2),DATAPT(178,3),DATAPT(178,4),
1DATAPT(178,5)/1005.2, 16.5, .70, .363, 598.0/
 DATA LAT(179),LON(179),ELEV1(179)/ 39.36,  2.42,  45./
 DATA DATAPT(179,1),DATAPT(179,2),DATAPT(179,3),DATAPT(179,4),
1DATAPT(179,5)/1010.3, 16.8, .75, .157, 447.0/
 DATA LAT(180),LON(180),ELEV1(180)/ 39.52,  4.16,  59./
 DATA DATAPT(180,1),DATAPT(180,2),DATAPT(180,3),DATAPT(180,4),
1DATAPT(180,5)/1008.9, 16.6, .72, .352, 637.0/
 DATA LAT(181),LON(181),ELEV1(181)/ 39.37, 19.55,   2./
 DATA DATAPT(181,1),DATAPT(181,2),DATAPT(181,3),DATAPT(181,4),
1DATAPT(181,5)/1014.1, 17.6, .71, .125,1311.0/
 DATA LAT(182),LON(182),ELEV1(182)/ 38.15, 21.44,   3./
 DATA DATAPT(182,1),DATAPT(182,2),DATAPT(182,3),DATAPT(182,4),
1DATAPT(182,5)/1014.3, 17.6, .69, .164, 753.0/
 DATA LAT(183),LON(183),ELEV1(183)/ 37.47, 20.53,   8./
 DATA DATAPT(183,1),DATAPT(183,2),DATAPT(183,3),DATAPT(183,4),
1DATAPT(183,5)/1014.2, 18.1, .69, .175, 933.0/
 DATA LAT(184),LON(184),ELEV1(184)/ 37.04, 22.01,   8./
 DATA DATAPT(184,1),DATAPT(184,2),DATAPT(184,3),DATAPT(184,4),
1DATAPT(184,5)/1014.0, 18.6, .68, .210, 813.0/
 DATA LAT(185),LON(185),ELEV1(185)/ 40.31, 22.58,   4./
 DATA DATAPT(185,1),DATAPT(185,2),DATAPT(185,3),DATAPT(185,4),
1DATAPT(185,5)/1015.4, 16.1, .66, .101, 465.0/
 DATA LAT(186),LON(186),ELEV1(186)/ 39.38, 22.25,  74./
 DATA DATAPT(186,1),DATAPT(186,2),DATAPT(186,3),DATAPT(186,4),
1DATAPT(186,5)/1005.9, 16.2, .67, .120, 488.0/
 DATA LAT(187),LON(187),ELEV1(187)/ 37.58, 23.43, 107./
 DATA DATAPT(187,1),DATAPT(187,2),DATAPT(187,3),DATAPT(187,4),
1DATAPT(187,5)/1002.1, 17.8, .63, .167, 403.0/
 DATA LAT(188),LON(188),ELEV1(188)/ 35.20, 25.11,  39./
 DATA DATAPT(188,1),DATAPT(188,2),DATAPT(188,3),DATAPT(188,4),
1DATAPT(188,5)/1010.0, 18.9, .65, .320, 441.0/
 DATA LAT(189),LON(189),ELEV1(189)/ 35.09, 33.17, 220./
 DATA DATAPT(189,1),DATAPT(189,2),DATAPT(189,3),DATAPT(189,4),
1DATAPT(189,5)/ 987.0, 19.1, .61, .280, 339.0/
 DATA LAT(190),LON(190),ELEV1(190)/ 34.41, 32.49, 113./
 DATA DATAPT(190,1),DATAPT(190,2),DATAPT(190,3),DATAPT(190,4),
1DATAPT(190,5)/ 999.8, 20.0, .61, .245, 450.0/
 DATA LAT(191),LON(191),ELEV1(191)/ 41.17, 36.20,  44./
 DATA DATAPT(191,1),DATAPT(191,2),DATAPT(191,3),DATAPT(191,4),
1DATAPT(191,5)/1010.2, 14.3, .73, .045, 731.0/
 DATA LAT(192),LON(192),ELEV1(192)/ 41.40, 26.34,  48./
 DATA DATAPT(192,1),DATAPT(192,2),DATAPT(192,3),DATAPT(192,4),
1DATAPT(192,5)/1011.0, 13.4, .71, .098, 727.0/
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 DATA LAT(193),LON(193),ELEV1(193)/ 40.58, 29.05,  40./
 DATA DATAPT(193,1),DATAPT(193,2),DATAPT(193,3),DATAPT(193,4),
1DATAPT(193,5)/1011.1, 12.6, .75, .078, 686.0/
 DATA LAT(194),LON(194),ELEV1(194)/ 40.11, 29.04, 100./
 DATA DATAPT(194,1),DATAPT(194,2),DATAPT(194,3),DATAPT(194,4),
1DATAPT(194,5)/1002.6, 14.4, .69, .075, 726.0/
 DATA LAT(195),LON(195),ELEV1(195)/ 40.08, 26.24,   3./
 DATA DATAPT(195,1),DATAPT(195,2),DATAPT(195,3),DATAPT(195,4),
1DATAPT(195,5)/1015.2, 14.7, .70, .150, 608.0/
 DATA LAT(196),LON(196),ELEV1(196)/ 38.26, 27.10,  25./
 DATA DATAPT(196,1),DATAPT(196,2),DATAPT(196,3),DATAPT(196,4),
1DATAPT(196,5)/1010.3, 17.5, .62, .271, 694.0/
 DATA LAT(197),LON(197),ELEV1(197)/ 36.42, 30.44,  50./
 DATA DATAPT(197,1),DATAPT(197,2),DATAPT(197,3),DATAPT(197,4),
1DATAPT(197,5)/1006.6, 18.6, .65, .453,1038.0/
 DATA LAT(198),LON(198),ELEV1(198)/ 37.00, 35.25,  66./
 DATA DATAPT(198,1),DATAPT(198,2),DATAPT(198,3),DATAPT(198,4),
1DATAPT(198,5)/1004.6, 18.6, .65, .335, 638.0/
 DATA LAT(199),LON(199),ELEV1(199)/ 41.22, 33.46, 799./
 DATA DATAPT(199,1),DATAPT(199,2),DATAPT(199,3),DATAPT(199,4),
1DATAPT(199,5)/ 921.7,  9.7, .70, .206, 440.0/
 DATA LAT(200),LON(200),ELEV1(200)/ 37.12, 28.21, 646./
 DATA DATAPT(200,1),DATAPT(200,2),DATAPT(200,3),DATAPT(200,4),
1DATAPT(200,5)/ 937.3, 14.9, .60, .420,1188.0/
 DATA LAT(201),LON(201),ELEV1(201)/ 45.26,  9.17, 103./
 DATA DATAPT(201,1),DATAPT(201,2),DATAPT(201,3),DATAPT(201,4),
1DATAPT(201,5)/1003.1, 12.3, .79, .141, 902.0/
 DATA LAT(202),LON(202),ELEV1(202)/ 45.23, 10.52,  68./
 DATA DATAPT(202,1),DATAPT(202,2),DATAPT(202,3),DATAPT(202,4),
1DATAPT(202,5)/1008.0, 12.4, .78, .202, 755.0/
 DATA LAT(203),LON(203),ELEV1(203)/ 43.40, 10.23,   1./
 DATA DATAPT(203,1),DATAPT(203,2),DATAPT(203,3),DATAPT(203,4),
1DATAPT(203,5)/1014.7, 14.9, .77, .209, 935.0/
 DATA LAT(204),LON(204),ELEV1(204)/ 41.48, 12.14,   3./
 DATA DATAPT(204,1),DATAPT(204,2),DATAPT(204,3),DATAPT(204,4),
1DATAPT(204,5)/1014.2, 15.9, .74, .162, 749.0/
 DATA LAT(205),LON(205),ELEV1(205)/ 40.57, 14.18,  72./
 DATA DATAPT(205,1),DATAPT(205,2),DATAPT(205,3),DATAPT(205,4),
1DATAPT(205,5)/1006.4, 15.8, .73, .109, 922.0/
 DATA LAT(206),LON(206),ELEV1(206)/ 45.39, 13.45,  20./
 DATA DATAPT(206,1),DATAPT(206,2),DATAPT(206,3),DATAPT(206,4),
1DATAPT(206,5)/1013.0, 14.5, .67, .113, 965.0/
 DATA LAT(207),LON(207),ELEV1(207)/ 45.30, 12.20,   6./
 DATA DATAPT(207,1),DATAPT(207,2),DATAPT(207,3),DATAPT(207,4),
1DATAPT(207,5)/1015.1, 12.8, .76, .130, 854.0/
 DATA LAT(208),LON(208),ELEV1(208)/ 45.37, 13.31, 104./
 DATA DATAPT(208,1),DATAPT(208,2),DATAPT(208,3),DATAPT(208,4),
1DATAPT(208,5)/1002.8, 14.8, .72, .064, 674.0/
 DATA LAT(209),LON(209),ELEV1(209)/ 42.26, 14.12,  16./
 DATA DATAPT(209,1),DATAPT(209,2),DATAPT(209,3),DATAPT(209,4),
1DATAPT(209,5)/1013.2, 14.4, .78, .141, 678.0/
 DATA LAT(210),LON(210),ELEV1(210)/ 40.26, 16.53,  12./
 DATA DATAPT(210,1),DATAPT(210,2),DATAPT(210,3),DATAPT(210,4),
1DATAPT(210,5)/1012.8, 17.1, .70, .082, 397.0/
 DATA LAT(211),LON(211),ELEV1(211)/ 40.39, 17.57,  10./
 DATA DATAPT(211,1),DATAPT(211,2),DATAPT(211,3),DATAPT(211,4),
1DATAPT(211,5)/1012.8, 16.3, .76, .136, 582.0/
 DATA LAT(212),LON(212),ELEV1(212)/ 40.38,  8.17,  40./
 DATA DATAPT(212,1),DATAPT(212,2),DATAPT(212,3),DATAPT(212,4),
1DATAPT(212,5)/1010.5, 15.9, .76, .181, 529.0/
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 DATA LAT(213),LON(213),ELEV1(213)/ 39.15,  9.03,  18./
 DATA DATAPT(213,1),DATAPT(213,2),DATAPT(213,3),DATAPT(213,4),
1DATAPT(213,5)/1013.0, 16.5, .76, .171, 432.0/
 DATA LAT(214),LON(214),ELEV1(214)/ 37.55, 12.30,  14./
 DATA DATAPT(214,1),DATAPT(214,2),DATAPT(214,3),DATAPT(214,4),
1DATAPT(214,5)/1013.4, 17.2, .73, .093, 516.0/
 DATA LAT(215),LON(215),ELEV1(215)/ 37.28, 15.03,  17./
 DATA DATAPT(215,1),DATAPT(215,2),DATAPT(215,3),DATAPT(215,4),
1DATAPT(215,5)/1013.2, 17.2, .76, .159, 643.0/
 DATA LAT(216),LON(216),ELEV1(216)/ 38.12, 15.33,  51./
 DATA DATAPT(216,1),DATAPT(216,2),DATAPT(216,3),DATAPT(216,4),
1DATAPT(216,5)/1008.9, 17.9, .70, .092, 973.0/
 DATA LAT(217),LON(217),ELEV1(217)/ 35.51, 14.29,  72./
 DATA DATAPT(217,1),DATAPT(217,2),DATAPT(217,3),DATAPT(217,4),
1DATAPT(217,5)/1006.1, 18.7, .61, .220, 640.0/
 DATA LAT(218),LON(218),ELEV1(218)/ 43.31, 16.26, 128./
 DATA DATAPT(218,1),DATAPT(218,2),DATAPT(218,3),DATAPT(218,4),
1DATAPT(218,5)/ 999.8, 16.1, .60, .125, 816.0/
 DATA LAT(219),LON(219),ELEV1(219)/ 42.22, 19.15,  33./
 DATA DATAPT(219,1),DATAPT(219,2),DATAPT(219,3),DATAPT(219,4),
1DATAPT(219,5)/1011.0, 15.4, .64, .165,1632.0/
 DATA LAT(220),LON(220),ELEV1(220)/ 41.57, 21.38, 233./
 DATA DATAPT(220,1),DATAPT(220,2),DATAPT(220,3),DATAPT(220,4),
1DATAPT(220,5)/ 989.0, 12.4, .72, .160, 544.0/
 DATA LAT(221),LON(221),ELEV1(221)/ 35.37,  -.36,  94./
 DATA DATAPT(221,1),DATAPT(221,2),DATAPT(221,3),DATAPT(221,4),
1DATAPT(221,5)/1005.2, 17.2, .77, .239, 394.0/
 DATA LAT(222),LON(222),ELEV1(222)/ 36.43,  3.15,  25./
 DATA DATAPT(222,1),DATAPT(222,2),DATAPT(222,3),DATAPT(222,4),
1DATAPT(222,5)/1013.3, 17.3, .77, .310, 691.0/
 DATA LAT(223),LON(223),ELEV1(223)/ 36.50, 10.14,   4./
 DATA DATAPT(223,1),DATAPT(223,2),DATAPT(223,3),DATAPT(223,4),
1DATAPT(223,5)/1014.4, 18.3, .72, .195, 470.0/
 DATA LAT(224),LON(224),ELEV1(224)/ 35.30, 35.48,   9./
 DATA DATAPT(224,1),DATAPT(224,2),DATAPT(224,3),DATAPT(224,4),
1DATAPT(224,5)/1010.1, 18.2, .65, .335, 714.0/
 DATA LAT(225),LON(225),ELEV1(225)/ 34.27, 35.48,  10./
 DATA DATAPT(225,1),DATAPT(225,2),DATAPT(225,3),DATAPT(225,4),
1DATAPT(225,5)/1011.9, 19.1, .67, .295, 745.0/
 DATA LAT(226),LON(226),ELEV1(226)/ 33.49, 35.29,  16./
 DATA DATAPT(226,1),DATAPT(226,2),DATAPT(226,3),DATAPT(226,4),
1DATAPT(226,5)/1011.2, 20.2, .68, .279, 517.0/
 DATA LAT(227),LON(227),ELEV1(227)/ 32.00, 34.54,  49./
 DATA DATAPT(227,1),DATAPT(227,2),DATAPT(227,3),DATAPT(227,4),
1DATAPT(227,5)/1007.7, 19.3, .70, .269, 529.0/
 DATA LAT(228),LON(228),ELEV1(228)/ 31.47, 35.13, 809./
 DATA DATAPT(228,1),DATAPT(228,2),DATAPT(228,3),DATAPT(228,4),
1DATAPT(228,5)/ 921.1, 16.9, .58, .093, 492.0/
 DATA LAT(229),LON(229),ELEV1(229)/ 46.39, 14.21, 452./
 DATA DATAPT(229,1),DATAPT(229,2),DATAPT(229,3),DATAPT(229,4),
1DATAPT(229,5)/ 963.4,  7.7, .81, .137, 925.0/
 DATA LAT(230),LON(230),ELEV1(230)/ 47.03, 12.57,3107./
 DATA DATAPT(230,1),DATAPT(230,2),DATAPT(230,3),DATAPT(230,4),
1DATAPT(230,5)/ 692.7, -6.0, .84, .090,1495.0/
 DATA LAT(231),LON(231),ELEV1(231)/ 46.02, 13.11,  92./
 DATA DATAPT(231,1),DATAPT(231,2),DATAPT(231,3),DATAPT(231,4),
1DATAPT(231,5)/1005.0, 13.2, .68, .154,1441.0/
 DATA LAT(232),LON(232),ELEV1(232)/ 45.49, 15.59, 163./
 DATA DATAPT(232,1),DATAPT(232,2),DATAPT(232,3),DATAPT(232,4),
1DATAPT(232,5)/ 997.3, 11.6, .72, .163, 864.0/
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      DATA LAT(233),LON(233),ELEV1(233)/ 43.52, 18.26, 637./
      DATA DATAPT(233,1),DATAPT(233,2),DATAPT(233,3),DATAPT(233,4),
     1DATAPT(233,5)/ 941.7,  9.8, .72, .149, 889.0/
      DATA LAT(234),LON(234),ELEV1(234)/ 43.12, 27.55,  41./
      DATA DATAPT(234,1),DATAPT(234,2),DATAPT(234,3),DATAPT(234,4),
     1DATAPT(234,5)/1011.6, 10.9, .75, .123, 475.0/
      DATA LAT(235),LON(235),ELEV1(235)/ 45.09, 29.40,   9./
      DATA DATAPT(235,1),DATAPT(235,2),DATAPT(235,3),DATAPT(235,4),
     1DATAPT(235,5)/1015.7, 11.0, .78, .110, 352.0/
      DATA LAT(236),LON(236),ELEV1(236)/ 44.13, 28.38,  32./
      DATA DATAPT(236,1),DATAPT(236,2),DATAPT(236,3),DATAPT(236,4),
     1DATAPT(236,5)/1012.4, 10.7, .76, .090, 375.0/
      DATA LAT(237),LON(237),ELEV1(237)/ 49.04, 20.15, 709./
      DATA DATAPT(237,1),DATAPT(237,2),DATAPT(237,3),DATAPT(237,4),
     1DATAPT(237,5)/ 931.8,  5.7, .77, .153, 608.0/
      DATA LAT(238),LON(238),ELEV1(238)/ 48.08, 20.48, 120./
      DATA DATAPT(238,1),DATAPT(238,2),DATAPT(238,3),DATAPT(238,4),
     1DATAPT(238,5)/1002.0,  9.7, .77, .165, 600.0/
      DATA LAT(239),LON(239),ELEV1(239)/ 47.31, 19.02, 130./
      DATA DATAPT(239,1),DATAPT(239,2),DATAPT(239,3),DATAPT(239,4),
     1DATAPT(239,5)/1000.6, 11.2, .69, .180, 630.0/
      DATA LAT(240),LON(240),ELEV1(240)/ 47.27, 21.38, 114./
      DATA DATAPT(240,1),DATAPT(240,2),DATAPT(240,3),DATAPT(240,4),
     1DATAPT(240,5)/1002.8, 10.3, .75, .160, 558.0/
      DATA LAT(241),LON(241),ELEV1(241)/ 46.00, 18.14, 202./
      DATA DATAPT(241,1),DATAPT(241,2),DATAPT(241,3),DATAPT(241,4),
     1DATAPT(241,5)/ 992.3, 11.5, .71, .162, 683.0/
      DATA LAT(242),LON(242),ELEV1(242)/ 46.15, 20.06,  84./
      DATA DATAPT(242,1),DATAPT(242,2),DATAPT(242,3),DATAPT(242,4),
     1DATAPT(242,5)/1006.1, 11.5, .73, .173, 559.0/
      DATA LAT(243),LON(243),ELEV1(243)/ 44.48, 20.28, 132./
      DATA DATAPT(243,1),DATAPT(243,2),DATAPT(243,3),DATAPT(243,4),
     1DATAPT(243,5)/1001.0, 11.8, .70, .155, 659.0/
      DATA LAT(244),LON(244),ELEV1(244)/ 43.49, 23.14,  33./
      DATA DATAPT(244,1),DATAPT(244,2),DATAPT(244,3),DATAPT(244,4),
     1DATAPT(244,5)/1012.8, 11.7, .74, .158, 555.0/
      DATA LAT(245),LON(245),ELEV1(245)/ 42.49, 23.23, 588./
      DATA DATAPT(245,1),DATAPT(245,2),DATAPT(245,3),DATAPT(245,4),
     1DATAPT(245,5)/ 950.7, 10.4, .72, .149, 622.0/
      DATA LAT(246),LON(246),ELEV1(246)/ 47.10, 27.36, 103./
      DATA DATAPT(246,1),DATAPT(246,2),DATAPT(246,3),DATAPT(246,4),
     1DATAPT(246,5)/1005.7,  9.4, .71, .125, 506.0/
      DATA LAT(247),LON(247),ELEV1(247)/ 45.46, 21.15,  91./
      DATA DATAPT(247,1),DATAPT(247,2),DATAPT(247,3),DATAPT(247,4),
     1DATAPT(247,5)/1005.3, 10.9, .73, .175, 625.0/
      DATA LAT(248),LON(248),ELEV1(248)/ 45.48, 24.09, 452./
      DATA DATAPT(248,1),DATAPT(248,2),DATAPT(248,3),DATAPT(248,4),
     1DATAPT(248,5)/ 960.5,  7.7, .74, .155, 643.0/
      DATA LAT(249),LON(249),ELEV1(249)/ 44.25, 26.06,  82./
      DATA DATAPT(249,1),DATAPT(249,2),DATAPT(249,3),DATAPT(249,4),
     1DATAPT(249,5)/1007.0, 11.1, .70, .095, 579.0/
C
C. . .FUNCTION DECIML CONVERTS DEGREES-MINUTES (DD.MM) INTO DECIMAL
C. . .DEGREES.
C
      DECIML(X)=FLOAT(INT(X))+(X-FLOAT(INT(X)))/.60
C
C. . .INITIALIZATION.
C
      DATA N,NOF,NDPM,NIP/249,20,15,1/
```

```
      NCP=5
      CONTUR=35.0
C
C.....ERROR CHECK ON INTERPOLATION POINT.
C
      IF(XLAT.GT.52.4.OR.XLAT.LT.40.0.OR.XLON.GT.25.0.OR.XLON.LT.1.2)
     1WRITE(6,1000)
C
C.....CONVERT POSITIONS OF DATA POINTS TO DECIMAL DEGREES AND REDUCE
C.....PRESSURE TO SEA LEVEL FOR MORE ACCURATE INTERPOLATION.
C
      DO 100 I=1,N
      DECLAT(I)=DECIML(LAT(I))
      DECLON(I)=DECIML(LON(I))
      PRS(I)=DATAPT(I,1)*EXP(9.8*ELEV1(I)/(287.04*(273.16+DATAPT(I,2))))
  100 CONTINUE
C
C. . .CONVERT POSITION OF INTERPOLATION POINT TO DECIMAL DEGREES.
C
      DCXLAT=DECIML(XLAT)
      DCXLON=DECIML(XLON)
C
C. . .ROUND ELEVATION TO CLOSEST CONTOUR INTERVAL.
C
      E1=ELEV/CONTUR
      E2=AINT(E1)
      E3=AINT((E1-E2)/.5)
      ELV=(E2+E3)*CONTUR
C
C.....FIND THE 20 DATA STATIONS CLOSEST TO THE INTERPOLATION POINT AND
C.....STORE THEIR SUBSCRIPTS IN ARRAY ISUB.
C
      DO 300 J=1,NDP
      CLSDIS=1.0E+6
      JJ=J-1
      DO 300 K=1,N
      TRYDIS=(DCXLAT-DECLAT(K))**2+(DCXLON-DECLON(K))**2
      IF(TRYDIS-CLSDIS)10,10,300
   10 IF(JJ)30,30,20
   20 DO 200 L=1,JJ
      IF(ISUB(L)-K)200,300,200
  200 CONTINUE
   30 CLSDIS=TRYDIS
      ISUB(J)=K
  300 CONTINUE
C
C.....PUT METEOROLOGICAL DATA FROM THE 20 STATIONS INTO ARRAYS TO SEND
C.....TO IOBVIP.
C
      DO 400 K=1,NDP
      KK=ISUB(K)
      PRESS(K)=PRS(KK)
      TEMP(K)=DATAPT(KK,2)
      RELHUM(K)=DATAPT(KK,3)
      BETA(K)=DATAPT(KK,4)
      MM(K)=DATAPT(KK,5)
      LATT(K)=DECLAT(KK)
  400 LONG(K)=DECLON(KK)
C
C.....IOBVIP DOES THE INTERPOLATIONS (AKIMA,1975).
```

```
C
      CALL IDBVIP(1,NDP,LATT,LONG,PRESS,NIP,DCXLAT,DCXLON,PRES,IWK,WK)
      CALL IDBVIP(3,NDP,LATT,LONG,TEMP,NIP,DCXLAT,DCXLON,TMP,IWK,WK)
      CALL IDBVIP(3,NDP,LATT,LONG,RELHUM,NIP,DCXLAT,DCXLON,RLHUM,IWK,WK)
      CALL IDBVIP(3,NDP,LATT,LONG,BETA,NIP,DCXLAT,DCXLON,BET,IWK,WK)
      CALL IDBVIP(1,NDPM,LATT,LONG,MM,NIP,DCXLAT,DCXLON,M,IWK,WK)
C
C.....EVALUATE STATION PRESSURE FROM PSEUDO-SEA-LEVEL VALUE AT THE
C.....INTERPOLATION POINT.
C
      PRES=PRES*EXP(-9.8*ELV/(287.04*(273.16+TMP)))
      RETURN
 1000 FORMAT(12H0* WARNING */70H INTERPOLATION PT OUT OF DESIGNATED BOUN
     1DS (SEE INITIAL COMMENT CARDS),/)
      END
```

```
      SUBROUTINE  IDBVIP(MD,NDP,XD,YD,ZD,NIP,XI,YI,ZI,IWK,WK)
C THIS SUBROUTINE PERFORMS BIVARIATE INTERPOLATION WHEN THE PRO-
C JECTIONS OF THE DATA POINTS IN THE X-Y PLANE ARE IRREGULARLY
C DISTRIBUTED IN THE PLANE.
C THE INPUT PARAMETERS ARE
C     MD  = MODE OF COMPUTATION (MUST BE 1, 2, OR 3),
C         = 1 FOR NEW XD-YD,
C         = 2 FOR OLD XD-YD, NEW XI-YI,
C         = 3 FOR OLD XD-YD, OLD XI-YI,
C     NDP = NUMBER OF DATA POINTS (MUST BE 4 OR GREATER),
C     XD  = ARRAY OF DIMENSION NDP CONTAINING THE X
C           COORDINATES OF THE DATA POINTS,
C     YD  = ARRAY OF DIMENSION NDP CONTAINING THE Y
C           COORDINATES OF THE DATA POINTS,
C     ZD  = ARRAY OF DIMENSION NDP CONTAINING THE Z
C           COORDINATES OF THE DATA POINTS,
C     NIP = NUMBER OF OUTPUT POINTS AT WHICH INTERPOLATION
C           IS TO BE PERFORMED (MUST BE 1 OR GREATER),
C     XI  = ARRAY OF DIMENSION NIP CONTAINING THE X
C           COORDINATES OF THE OUTPUT POINTS,
C     YI  = ARRAY OF DIMENSION NIP CONTAINING THE Y
C           COORDINATES OF THE OUTPUT POINTS.
C THE OUTPUT PARAMETER IS
C     ZI  = ARRAY OF DIMENSION NIP WHERE INTERPOLATED Z
C           VALUES ARE TO BE STORED.
C THE OTHER PARAMETERS ARE
C     IWK = INTEGER ARRAY OF DIMENSION
C              MAX0(31,27+NCP)*NDP+NIP
C           TO BE USED AS A WORK AREA,
C     WK  = ARRAY OF DIMENSION 8*NDP TO BE USED AS A
C           WORK AREA,
C WHERE NCP IS THE NUMBER OF ADDITIONAL DATA POINTS USED FOR
C ESTIMATING PARTIAL DERIVATIVES AT EACH DATA POINT.  THE VALUE
C OF NCP MUST BE GIVEN THROUGH THE IDCM COMMON.  NCP MUST BE 2
C OR GREATER, BUT SMALLER THAN NDP.
C THE LUN CONSTANT IN THE DATA INITIALIZATION STATEMENT IS THE
C LOGICAL UNIT NUMBER OF THE STANDARD OUTPUT UNIT AND IS,
C THEREFORE, SYSTEM DEPENDENT.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),ZD(100),XI(1000),YI(1000),
     1            ZI(1000),IWK(4100),WK(800)
      COMMON/IDCM/NCP
      COMMON/IDLC/NIT
      COMMON/IDPI/NCF
      DATA  LUN/6/
C SETTING OF SOME INPUT PARAMETERS TO LOCAL VARIABLES.
C (FOR MD=1,2,3)
   10 MD0=MD
      NDP0=NDP
      NIP0=NIP
      NCP0=NCP
C ERROR CHECK.  (FOR MD=1,2,3)
   20 IF(MD0.LT.1.OR.MD0.GT.3)             GO TO 90
      IF(NDP0.LT.4)                        GO TO 90
      IF(NIP0.LT.1)                        GO TO 90
      IF(NCP0.LT.2.OR.NCP0.GE.NDP0)        GO TO 90
      IF(MD0.GE.2)         GO TO 21
      IWK(1)=NDP0
      IWK(2)=NCP0
      GO TO 22
```

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   21 NDPPV=IWK(1)
      NCPPV=IWK(2)
      IF(NDP0.NE.NDPPV)     GO TO 90
      IF(NCP0.NE.NCPPV)     GO TO 90
   22 IF(MD0.GE.3)          GO TO 23
      IWK(3)=NIP
      GO TO 30
   23 NIPPV=IWK(3)
      IF(NIP0.NE.NIPPV)     GO TO 90
C ALLOCATION OF STORAGE AREAS IN THE IWK ARRAY.  (FOR MD=1,2,3)
   30 JWIPT=16
      JWIWL=6*NDP0+1
      JWIWK=JWIWL
      JWIPL=24*NDP0+1
      JWIWP=30*NDP0+1
      JWIPC=27*NDP0+1
      JWIT0=MAX0(31,27+NCP0)*NDP0
C TRIANGULATES THE X-Y PLANE.  (FOR MD=1)
   40 IF(MD0.GT.1)   GO TO 50
      CALL  IDTANG(NDP0,XD,YD,NT,IWK(JWIPT),NL,IWK(JWIPL),
     1             IWK(JWIWL),IWK(JWIWP),WK)
      IWK(5)=NT
      IWK(6)=NL
      IWK(5)=NT
      IWK(6)=NL
      IF(NT.EQ.0)    RETURN
C DETERMINES NCP POINTS CLOSEST EACH DATA POINT.  (FOR MD=1)
   50 IF(MD0.GT.1)   GO TO 60
      CALL IDCLDP(NDP0,XD,YD,NCP0,IWK(JWIPC))
      IF(IWK(JWIPC).EQ.0)         RETURN
C LOCATES ALL POINTS AT WHICH INTERPOLATION IS TO BE PERFORMED.
C (FOR MD=1,2)
   60 IF(MD0.EQ.3)   GO TO 70
      NIT=0
      JWIT=JWIT0
      DO 61   IIP=1,NIP0
        JWIT=JWIT+1
        CALL IDLCTN(NDP0,XD,YD,NT,IWK(JWIPT),NL,IWK(JWIPL),
     1             XI(IIP),YI(IIP),IWK(JWIT),IWK(JWIWK),WK)
   61 CONTINUE
C ESTIMATES PARTIAL DERIVATIVES AT ALL DATA POINTS.
C (FOR MD=1,2,3)
   70 CALL IDPDRV(NDP0,XD,YD,ZD,NCP0,IWK(JWIPC),WK)
C INTERPOLATES THE ZI VALUES.  (FOR MD=1,2,3)
   80 NCF=0
      JWIT=JWIT0
      DO 81   IIP=1,NIP0
        JWIT=JWIT+1
        CALL IDPTIP(XD,YD,ZD,NT,IWK(JWIPT),NL,IWK(JWIPL),WK,
     1                 IWK(JWIT),XI(IIP),YI(IIP),ZI(IIP))
   81 CONTINUE
      RETURN
C ERROR EXIT
   90 WRITE (LUN,2090) MD0,NDP0,NIP0,NCP0
      RETURN
C FORMAT STATEMENT FOR ERROR MESSAGE
 2090 FORMAT(1X/41H ***    IMPROPER INPUT PARAMETER VALUE(S)./
     1   7H   MD =,I4,10X,5HNDP =,I6,10X,5HNIP =,I6,
     2   10X,5HNCP =,I6/
     3   35H ERROR DETECTED IN ROUTINE    IDBVIP/)
       END
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      SUBROUTINE  IDCLDP(NDP,XD,YD,NCP,IPC)
C THIS SUBROUTINE SELECTS SEVERAL DATA POINTS THAT ARE CLOSEST
C TO EACH OF THE DATA POINT.
C THE INPUT PARAMETERS ARE
C     NDP = NUMBER OF DATA POINTS,
C     XD,YD = ARRAYS CONTAINING THE X AND Y COORDINATES
C             OF DATA POINTS,
C     NCP = NUMBER OF DATA POINTS CLOSEST TO EACH DATA
C           POINTS.
C THE OUTPUT PARAMETER IS
C     IPC = ARRAY OF DIMENSION NCP*NDP, WHERE THE POINT
C           NUMBERS OF NCP DATA POINTS CLOSEST TO EACH OF
C           THE NDP DATA POINTS ARE TO BE STORED.
C THIS SUBROUTINE ARBITRARILY SETS A RESTRICTION THAT NCP MUST
C NOT EXCEED 25.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),IPC(400)
      DIMENSION   DSQ0(25),IPC0(25)
      DATA  NCPMX/25/, LUN/6/
C STATEMENT FUNCTION
      DSQF(X1,Y1,X2,Y2)=(X2-X1)**2+(Y2-Y1)**2
C PRELIMINARY PROCESSING
   10 NDP0=NDP
      NCP0=NCP
      IF(NDP0.LT.2)  GO TO 90
      IF(NCP0.LT.1.OR.NCP0.GT.NCPMX.OR.NCP0.GE.NDP0)      GO TO 90
C CALCULATION
   20 DO 29  IP1=1,NDP0
        X1=XD(IP1)
        Y1=YD(IP1)
        J1=0
        DSQMX=0.0
        DO 22  IP2=1,NDP0
          IF(IP2.EQ.IP1)  GO TO 22
          DSQI=DSQF(X1,Y1,XD(IP2),YD(IP2))
          J1=J1+1
          DSQ0(J1)=DSQI
          IPC0(J1)=IP2
          IF(DSQI.LE.DSQMX)      GO TO 21
          DSQMX=DSQI
          JMX=J1
   21     IF(J1.GE.NCP0)  GO TO 23
   22   CONTINUE
   23   IP2MN=IP2+1
        IF(IP2MN.GT.NDP0)        GO TO 26
        DO 25  IP2=IP2MN,NDP0
          IF(IP2.EQ.IP1)  GO TO 25
          DSQI=DSQF(X1,Y1,XD(IP2),YD(IP2))
          IF(DSQI.GE.DSQMX)      GO TO 25
          DSQ0(JMX)=DSQI
          IPC0(JMX)=IP2
          DSQMX=0.0
          DO 24  J1=1,NCP0
            IF(DSQ0(J1).LE.DSQMX)   GO TO 24
            DSQMX=DSQ0(J1)
            JMX=J1
   24     CONTINUE
   25   CONTINUE
   26   J1=(IP1-1)*NCP0
        DO 28  J2=1,NCP0
```

```
         J1=J1+1
         IPC(J1)=IPC0(J2)
   28    CONTINUE
   29 CONTINUE
      RETURN
C ERROR EXIT
   90 WRITE (LUN,2090)   NDP0,NCP0
      IPC(1)=0
      RETURN
C FORMAT STATEMENT
 2090 FORMAT(1X/41H ***    IMPROPER INPUT PARAMETER VALUE(S)./
     1   8H    NDP =,I5,5X,5HNCP =,I5/
     2   35H ERROR DETECTED IN ROUTINE    IDCLDP/)
      END
```

```
      SUBROUTINE  IDGRID(XD,YD,NT,IPT,NL,IPL,NXI,NYI,XI,YI,
     1                   NGP,IGP)
C THIS SUBROUTINE ORGANIZES GRID POINTS FOR SURFACE FITTING BY
C SORTING THEM IN ASCENDING ORDER OF TRIANGLE NUMBERS AND OF THE
C BORDER LINE SEGMENT NUMBER.
C THE INPUT PARAMETERS ARE
C     XD,YD = ARRAYS CONTAINING THE X AND Y COORDINATES OF
C             DATA POINTS,
C     NT  = NUMBER OF TRIANGLES,
C     IPT = ARRAY CONTAINING THE POINT NUMBERS OF THE
C           VERTEXES OF THE TRIANGLES,
C     NL  = NUMBER OF BORDER LINE SEGMENTS,
C     IPL = ARRAY CONTAINING THE POINT NUMBERS OF THE END
C           POINTS OF THE BORDER LINE SEGMENTS AND THEIR
C           RESPECTIVE TRIANGLE NUMBERS,
C     NXI = NUMBER OF GRID POINTS IN THE X COORDINATE,
C     NYI = NUMBER OF GRID POINTS IN THE Y COORDINATE,
C     XI,YI = ARRAYS CONTAINING THE X AND Y COORDINATES OF
C             THE GRID POINTS.
C THE OUTPUT PARAMETERS ARE
C     NGP = INTEGER ARRAY OF DIMENSION 2*(NT+2*NL) WHERE THE
C           NUMBER OF GRID POINTS THAT BELONG TO EACH OF THE
C           TRIANGLES OR OF THE BORDER LINE SEGMENTS ARE TO
C           BE STORED,
C     IGP = INTEGER ARRAY OF DIMENSION NXI*NYI WHERE THE
C           GRID POINT NUMBERS ARE TO BE STORED IN ASCENDING
C           ORDER OF THE TRIANGLE NUMBER AND THE BORDER LINE
C           SEGMENT NUMBER.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),IPT(585),IPL(300),
     1            XI(101),YI(101),NGP(800),IGP(10201)
C PRELIMINARY PROCESSING
   10 NT0=NT
      NL0=NL
      NXI0=NXI
      NYI0=NYI
      NXINYI=NXI0*NYI0
      XIMN=AMIN1(XI(1),XI(NXI0))
      XIMX=AMAX1(XI(1),XI(NXI0))
      YIMN=AMIN1(YI(1),YI(NYI0))
      YIMX=AMAX1(YI(1),YI(NYI0))
C DETERMINES GRID POINTS INSIDE THE DATA AREA.
   20 JNGP0=0
      JNGP1=2*(NT0+2*NL0)+1
      JIGP0=0
      JIGP1=NXINYI+1
      DO 39  IT0=1,NT0
        NGP0=0
        NGP1=0
        IT0T3=IT0*3
        IP1=IPT(IT0T3-2)
        IP2=IPT(IT0T3-1)
        IP3=IPT(IT0T3)
        X1=XD(IP1)
        Y1=YD(IP1)
        X2=XD(IP2)
        Y2=YD(IP2)
        X3=XD(IP3)
        Y3=YD(IP3)
        XMN=AMIN1(X1,X2,X3)
```

```
      XMX=AMAX1(X1,X2,X3)
      YMN=AMIN1(Y1,Y2,Y3)
      YMX=AMAX1(Y1,Y2,Y3)
      INSD=0
      DO 22  IXI=1,NXIO
        IF(XI(IXI).GE.XMN.AND.XI(IXI).LE.XMX)     GO TO 21
        IF(INSD.EQ.0)    GO TO 22
        IXIMX=IXI-1
        GO TO 23
   21   IF(INSD.EQ.1)    GO TO 22
        INSD=1
        IXIMN=IXI
   22 CONTINUE
      IF(INSD.EQ.0)     GO TO 38
      IXIMX=NXIO
   23 DX21=X2-X1
      DX32=X3-X2
      DX13=X1-X3
      DY21=Y2-Y1
      DY32=Y3-Y2
      DY13=Y1-Y3
      DO 37  IYI=1,NYIO
        YII=YI(IYI)
        IF(YII.LT.YMN.OR.YII.GT.YMX)          GO TO 37
        A1=(YII-Y1)*DX21
        A2=(YII-Y2)*DX32
        A3=(YII-Y3)*DX13
        DO 36  IXI=IXIMN,IXIMX
          XII=XI(IXI)
          L=0
          IF(A1-(XII-X1)*DY21)    36,25,26
   25     L=1
   26     IF(A2-(XII-X2)*DY32)    36,27,29
   27     L=1
   28     IF(A3-(XII-X3)*DY13)    36,29,30
   29     L=1
   30     IZI=NXIO*(IYI-1)+IXI
          IF(L.EQ.1)     GO TO 31
          NGPO=NGPO+1
          JIGPO=JIGPO+1
          IGP(JIGPO)=IZI
          GO TO 36
   31     IF(JIGP1.GT.NXINYI)    GO TO 33
          DO 32  JIGP1I=JIGP1,NXINYI
            IF(IZI.EQ.IGP(JIGP1I))       GO TO 36
   32     CONTINUE
   33     NGP1=NGP1+1
          JIGP1=JIGP1-1
          IGP(JIGP1)=IZI
   36   CONTINUE
   37 CONTINUE
   38 JNGPO=JNGPO+1
      NGP(JNGPO)=NGPO
      JNGP1=JNGP1-1
      NGP(JNGP1)=NGP1
   39 CONTINUE
C DETERMINES GRID POINTS OUTSIDE THE DATA AREA.
   40 DO 79  ILO=1,NLO
      NGPO=0
      NGP1=0
```

```
      ILOT3=ILO*3
      IP1=IPL(ILOT3-2)
      IP2=IPL(ILOT3-1)
      X1=XD(IP1)
      Y1=YD(IP1)
      X2=XD(IP2)
      Y2=YD(IP2)
      XMN=XIMN
      XMX=XIMX
      YMN=YIMN
      YMX=YIMX
      IF(Y2.GE.Y1)       XMN=AMIN1(X1,X2)
      IF(Y2.LE.Y1)       XMX=AMAX1(X1,X2)
      IF(X2.LE.X1)       YMN=AMIN1(Y1,Y2)
      IF(X2.GE.X1)       YMX=AMAX1(Y1,Y2)
      INSD=0
      DO 42  IXI=1,NXI0
        IF(XI(IXI).GE.XMN.AND.XI(IXI).LE.XMX)     GO TO 41
        IF(INSD.EQ.0)    GO TO 42
        IXIMX=IXI-1
        GO TO 43
41      IF(INSD.EQ.1)    GO TO 42
        INSD=1
        IXIMN=IXI
42    CONTINUE
      IF(INSD.EQ.0)      GO TO 58
      IXIMX=NXI0
43    DX21=X2-X1
      DY21=Y2-Y1
      DO 57  IYI=1,NYI0
        YII=YI(IYI)
        IF(YII.LT.YMN.OR.YII.GT.YMX)          GO TO 57
        A1=(YII-Y1)*DX21
        B1=(YII-Y1)*DY21
        B2=(YII-Y2)*DY21
        DO 56  IXI=IXIMN,IXIMX
          XII=XI(IXI)
          L=0
          IF(A1-(XII-X1)*DY21)     46,45,56
45        L=1
46        IF(DX21*(XII-X1)+B1)     56,47,48
47        L=1
48        IF(DX21*(XII-X2)+B2)     50,49,56
49        L=1
50        IZI=NXI0*(IYI-1)+IXI
          IF(L.EQ.1)     GO TO 51
          NGP0=NGP0+1
          JIGP0=JIGP0+1
          IGP(JIGP0)=IZI
          GO TO 56
51        IF(JIGP1.GT.NXINYI)      GO TO 53
          DO 52  JIGP1I=JIGP1,NXINYI
            IF(IZI.EQ.IGP(JIGP1I))      GO TO 56
52        CONTINUE
53        NGP1=NGP1+1
          JIGP1=JIGP1-1
          IGP(JIGP1)=IZI
56      CONTINUE
57    CONTINUE
58    JNGP0=JNGP0+1
```

```
      NGP(JNGP0)=NGP0
      JNGP1=JNGP1-1
      NGP(JNGP1)=NGP1
60    NGP0=0
      NGP1=0
      ILP1=MOD(IL0,NL0)+1
      ILP1T3=ILP1*3
      IP3=IPL(ILP1T3-1)
      X3=XD(IP3)
      Y3=YD(IP3)
      XMN=XIMN
      XMX=XIMX
      YMN=YIMN
      YMX=YIMX
      IF(Y3.GE.Y2.AND.Y2.GE.Y1)    XMN=X2
      IF(Y3.LE.Y2.AND.Y2.LE.Y1)    XMX=X2
      IF(X3.LE.X2.AND.X2.LE.X1)    YMN=Y2
      IF(X3.GE.X2.AND.X2.GE.X1)    YMX=Y2
      INSD=0
      DO 62  IXI=1,NXI0
        IF(XI(IXI).GE.XMN.AND.XI(IXI).LE.XMX)      GO TO 61
        IF(INSD.EQ.0)    GO TO 62
        IXIMX=IXI-1
        GO TO 63
61      IF(INSD.EQ.1)    GO TO 62
        INSD=1
        IXIMN=IXI
62    CONTINUE
      IF(INSD.EQ.0)      GO TO 78
      IXIMX=NXI0
63    DX21=X2-X1
      DY21=Y2-Y1
      DX32=X3-X2
      DY32=Y3-Y2
      DO 77  IYI=1,NYI0
        YII=YI(IYI)
        IF(YII.LT.YMN.OR.YII.GT.YMX)          GO TO 77
        B2=(YII-Y2)*DY21
        B3=(YII-Y2)*DY32
        DO 76  IXI=IXIMN,IXIMX
          XII=XI(IXI)
          L=0
          IF(DX21*(XII-X2)+B2)     76,65,66
65        L=1
66        IF(DX32*(XII-X2)+B3)     70,67,76
67        L=1
70        IZI=NXI0*(IYI-1)+IXI
          IF(L.EQ.1)    GO TO 71
          NGP0=NGP0+1
          JIGP0=JIGP0+1
          IGP(JIGP0)=IZI
          GO TO 76
71        IF(JIGP1.GT.NXINYI)      GO TO 73
          DO 72  JIGP1I=JIGP1,NXINYI
            IF(IZI.EQ.IGP(JIGP1I))      GO TO 76
72        CONTINUE
73        NGP1=NGP1+1
          JIGP1=JIGP1-1
          IGP(JIGP1)=IZI
76      CONTINUE
```

```
77    CONTINUE
78    JNGP0=JNGP0+1
      NGP(JNGP0)=NGP0
      JNGP1=JNGP1-1
      NGP(JNGP1)=NGP1
79 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE  IDLCTN(NDP,XD,YD,NT,IPT,NL,IPL,XII,YII,ITI,
     1                   IWK,WK)
C THIS SUBROUTINE LOCATES A POINT, I.E., DETERMINES TO WHAT TRI-
C ANGLE A GIVEN POINT (XII,YII) BELONGS.  WHEN THE GIVEN POINT
C DOES NOT LIE INSIDE THE DATA AREA, THIS SUBROUTINE DETERMINES
C THE BORDER LINE SEGMENT IN THE AREA ABOVE WHICH THE POINT
C LIES, OR TWO BORDER LINE SEGMENTS BETWEEN TWO AREAS ABOVE
C WHICH THE POINT LIES.
C THE INPUT PARAMETERS ARE
C     NDP = NUMBER OF DATA POINTS,
C     XD,YD = ARRAYS CONTAINING THE X AND Y COORDINATES
C             OF DATA POINTS,
C     NT  = NUMBER OF TRIANGLES,
C     IPT = ARRAY CONTAINING THE POINT NUMBERS OF THE
C           VERTEXES OF THE TRIANGLES,
C     NL  = NUMBER OF BORDER LINE SEGMENTS,
C     IPL = ARRAY CONTAINING THE POINT NUMBERS OF THE END
C           POINTS OF THE BORDER LINE SEGMENTS AND THEIR
C           RESPECTIVE TRIANGLE NUMBERS,
C     XII,YII = X AND Y COORDINATES OF THE POINT TO BE
C               LOCATED.
C THE OUTPUT PARAMETER IS
C     ITI = TRIANGLE NUMBER, WHEN THE POINT IS INSIDE THE
C           DATA AREA, OR
C           TWO BORDER LINE SEGMENT NUMBERS, IL1 AND IL2,
C           CODED TO IL1*(NT+NL)+IL2, WHEN THE POINT IS
C           OUTSIDE THE DATA AREA.
C THE OTHER PARAMETERS ARE
C     IWK = INTEGER ARRAY OF DIMENSION 18*NDP TO BE USED
C           INTERNALLY AS A WORK AREA,
C     WK  = ARRAY OF DIMENSION 8*NDP TO BE USED INTERNALLY
C           AS A WORK AREA.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),IPT(585),IPL(300),
     1            IWK(1800),WK(800)
      DIMENSION   NTSC(9),IDSC(9)
      COMMON/IDLC/NIT
C STATEMENT FUNCTION
      SIDE(X1,Y1,X2,Y2,X3,Y3)=(Y3-Y1)*(X2-X1)-(X3-X1)*(Y2-Y1)
C PRELIMINARY PROCESSING
   10 NDP0=NDP
      NT0=NT
      NL0=NL
      NTL=NT0+NL0
      X0=XII
      Y0=YII
C PROCESSING FOR A NEW SET OF DATA POINTS
   20 IF(NIT.NE.0)   GO TO 30
      NIT=1
C - DIVIDES THE X-Y PLANE INTO NINE RECTANGULAR SECTIONS.
      XMN=XD(1)
      XMX=XMN
      YMN=YD(1)
      YMX=YMN
      DO 21  IDP=2,NDP0
        XI=XD(IDP)
        YI=YD(IDP)
        IF(XI.LT.XMN)      XMN=XI
        IF(XI.GT.XMX)      XMX=XI
        IF(YI.LT.YMN)      YMN=YI
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      IF(YI.GT.YMX)      YMX=YI
   21 CONTINUE
      XS1=(XMN+XMN+XMX)/3.0
      XS2=(XMN+XMX+XMX)/3.0
      YS1=(YMN+YMN+YMX)/3.0
      YS2=(YMN+YMX+YMX)/3.0
C - DETERMINES AND STORES IN THE IWK ARRAY TRIANGLE NUMBERS OF
C - THE TRIANGLES ASSOCIATED WITH EACH OF THE NINE SECTIONS.
      DO 22  ISC=1,9
        NTSC(ISC)=0
        IDSC(ISC)=0
   22 CONTINUE
      ITOT3=0
      JWK=0
      DO 27  ITO=1,NTO
        ITOT3=ITOT3+3
        I1=IPT(ITOT3-2)
        I2=IPT(ITOT3-1)
        I3=IPT(ITOT3)
        XMN=AMIN1(XD(I1),XD(I2),XD(I3))
        XMX=AMAX1(XD(I1),XD(I2),XD(I3))
        YMN=AMIN1(YD(I1),YD(I2),YD(I3))
        YMX=AMAX1(YD(I1),YD(I2),YD(I3))
        IF(YMN.GT.YS1)                    GO TO 23
        IF(XMN.LE.XS1)                    IDSC(1)=1
        IF(XMX.GE.XS1.AND.XMN.LE.XS2)     IDSC(2)=1
        IF(XMX.GE.XS2)                    IDSC(3)=1
   23   IF(YMX.LT.YS1.OR.YMN.GT.YS2)      GO TO 24
        IF(XMN.LE.XS1)                    IDSC(4)=1
        IF(XMX.GE.XS1.AND.XMN.LE.XS2)     IDSC(5)=1
        IF(XMX.GE.XS2)                    IDSC(6)=1
   24   IF(YMX.LT.YS2)                    GO TO 25
        IF(XMN.LE.XS1)                    IDSC(7)=1
        IF(XMX.GE.XS1.AND.XMN.LE.XS2)     IDSC(8)=1
        IF(XMX.GE.XS2)                    IDSC(9)=1
   25   DO 26  ISC=1,9
          IF(IDSC(ISC).EQ.0)   GO TO 26
          JIWK=9*NTSC(ISC)+ISC
          IWK(JIWK)=ITO
          NTSC(ISC)=NTSC(ISC)+1
          IDSC(ISC)=0
   26   CONTINUE
C - STORES IN THE WK ARRAY THE MINIMUM AND MAXIMUM OF THE X AND
C - Y COORDINATE VALUES FOR EACH OF THE TRIANGLE.
        JWK=JWK+4
        WK(JWK-3)=XMN
        WK(JWK-2)=XMX
        WK(JWK-1)=YMN
        WK(JWK)  =YMX
   27 CONTINUE
      GO TO 60
C CHECKS IF IN THE SAME TRIANGLE AS PREVIOUS.
   30 ITO=ITIPV
      IF(ITO.GT.NTO)       GO TO 40
      ITOT3=ITO*3
      IP1=IPT(ITOT3-2)
      X1=XD(IP1)
      Y1=YD(IP1)
      IP2=IPT(ITOT3-1)
      X2=XD(IP2)
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      Y2=YD(IP2)
      IF(SIDE(X1,Y1,X2,Y2,X0,Y0).LT.0.0)          GO TO 60
      IP3=IPT(ITOT3)
      X3=XD(IP3)
      Y3=YD(IP3)
      IF(SIDE(X2,Y2,X3,Y3,X0,Y0).LT.0.0)          GO TO 60
      IF(SIDE(X3,Y3,X1,Y1,X0,Y0).LT.0.0)          GO TO 60
      GO TO 80
C CHECKS IF ON THE SAME BORDER LINE SEGMENT.
   40 IL1=IT0/NTL
      IL2=IT0-IL1*NTL
      IL1T3=IL1*3
      IP1=IPL(IL1T3-2)
      X1=XD(IP1)
      Y1=YD(IP1)
      IP2=IPL(IL1T3-1)
      X2=XD(IP2)
      Y2=YD(IP2)
      DX02=X0-X2
      DY02=Y0-Y2
      DX21=X2-X1
      DY21=Y2-Y1
      CS0221=DX02*DX21+DY02*DY21
      IF(IL2.NE.IL1)        GO TO 50
      IF(CS0221.GT.0.0)     GO TO 60
      DX01=X0-X1
      DY01=Y0-Y1
      IF(DY01*DX21-DX01*DY21.GT.0.0)       GO TO 60
      IF(DX01*DX21+DY01*DY21.LT.0.0)       GO TO 60
      GO TO 80
C CHECKS IF BETWEEN THE SAME TWO BORDER LINE SEGMENTS.
   50 IF(CS0221.LT.0.0)     GO TO 60
      IP3=IPL(3*IL2-1)
      X3=XD(IP3)
      Y3=YD(IP3)
      DX32=X3-X2
      DY32=Y3-Y2
      IF(DX02*DX32+DY02*DY32.LE.0.0)       GO TO 80
C LOCATES INSIDE THE DATA AREA.
C - DETERMINES THE SECTION IN WHICH THE POINT IN QUESTION LIES.
   60 ISC=1
      IF(X0.GE.XS1)         ISC=ISC+1
      IF(X0.GE.XS2)         ISC=ISC+1
      IF(Y0.GE.YS1)         ISC=ISC+3
      IF(Y0.GE.YS2)         ISC=ISC+3
C - SEARCHES THROUGH THE TRIANGLES ASSOCIATED WITH THE SECTION.
      NTSCI=NTSC(ISC)
      IF(NTSCI.LE.0)        GO TO 70
      JIWK=-9+ISC
      DO 61  ITSC=1,NTSCI
        JIWK=JIWK+9
        IT0=IWK(JIWK)
        JWK=IT0*4
        IF(X0.LT.WK(JWK-3))     GO TO 61
        IF(X0.GT.WK(JWK-2))     GO TO 61
        IF(Y0.LT.WK(JWK-1))     GO TO 61
        IF(Y0.GT.WK(JWK))       GO TO 61
        ITOT3=IT0*3
        IP1=IPT(ITOT3-2)
        X1=XD(IP1)
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      Y1=YD(IP1)
      IP2=IPT(ITOT3-1)
      X2=XD(IP2)
      Y2=YD(IP2)
      IF(SIDE(X1,Y1,X2,Y2,X0,Y0).LT.0.0)      GO TO 61
      IP3=IPT(ITOT3)
      X3=XD(IP3)
      Y3=YD(IP3)
      IF(SIDE(X2,Y2,X3,Y3,X0,Y0).LT.0.0)      GO TO 61
      IF(SIDE(X3,Y3,X1,Y1,X0,Y0).LT.0.0)      GO TO 61
      GO TO 80
   61 CONTINUE
C LOCATES OUTSIDE THE DATA AREA.
   70 NLOT3=NLO*3
      IP1=IPL(NLOT3-2)
      X1=XD(IP1)
      Y1=YD(IP1)
      IP2=IPL(NLOT3-1)
      X2=XD(IP2)
      Y2=YD(IP2)
      DX02=X0-X2
      DY02=Y0-Y2
      DX21=X2-X1
      DY21=Y2-Y1
      CS0221=DX02*DX21+DY02*DY21
      DO 72  IL2=1,NLO
        X1=X2
        Y1=Y2
        DX01=DX02
        DY01=DY02
        CSPV=CS0221
        IP2=IPL(3*IL2-1)
        X2=XD(IP2)
        Y2=YD(IP2)
        DX02=X0-X2
        DY02=Y0-Y2
        DX21=X2-X1
        DY21=Y2-Y1
        CS0221=DX02*DX21+DY02*DY21
        IF(CS0221.GT.0.0)       GO TO 72
        IF(DX01*DX21+DY01*DY21.LT.0.0)    GO TO 71
        IF(DY01*DX21-DX01*DY21.LE.0.0)    GO TO 74
        GO TO 72
   71   IF(CSPV.GT.0.0)         GO TO 73
   72 CONTINUE
      IL2=1
   73 IL1=IL2-1
      IF(IL1.EQ.0)    IL1=NLO
      GO TO 75
   74 IL1=IL2
   75 ITO=IL1*NTL+IL2
C NORMAL EXIT
   80 ITI=ITO
      ITIPV=ITO
      RETURN
      END
```

```
      SUBROUTINE  IDPDRV(NDP,XD,YD,ZD,NCP,IPC,PD)
C THIS SUBROUTINE ESTIMATES PARTIAL DERIVATIVES OF THE FIRST AND
C SECOND ORDER AT THE DATA POINTS.
C THE INPUT PARAMETERS ARE
C     NDP = NUMBER OF DATA POINTS,
C     XD,YD,ZD = ARRAYS CONTAINING THE X, Y, AND Z COORDI-
C                NATES OF DATA POINTS,
C     NCP = NUMBER OF DATA POINTS TO BE USED FOR ESTIMATION
C           OF PARTIAL DERIVATIVES AT EACH DATA POINT,
C     IPN = ARRAY CONTAINING THE POINT NUMBERS OF NCP DATA
C           POINTS CLOSEST TO EACH OF THE NCP DATA POINTS.
C THE OUTPUT PARAMETER IS
C     PD  = ARRAY OF DIMENSION 5*NDP, WHERE THE ESTIMATED
C           ZX, ZY, ZXX, ZXY, AND ZYY VALUES AT THE DATA
C           POINTS ARE TO BE STORED.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),ZD(100),IPC(400),PD(500)
      REAL        NMX,NMY,NMZ,NMXX,NMXY,NMYX,NMYY
C PRELIMINARY PROCESSING
   10 NDP0=NDP
      NCP0=NCP
      NCPM1=NCP0-1
C ESTIMATION OF ZX AND ZY
   20 DO 24  IP0=1,NDP0
        X0=XD(IP0)
        Y0=YD(IP0)
        Z0=ZD(IP0)
        NMX=0.0
        NMY=0.0
        NMZ=0.0
        JIPC0=NCP0*(IP0-1)
        DO 23  IC1=1,NCPM1
          JIPC=JIPC0+IC1
          IPI=IPC(JIPC)
          DX1=XD(IPI)-X0
          DY1=YD(IPI)-Y0
          DZ1=ZD(IPI)-Z0
          IC2MN=IC1+1
          DO 22  IC2=IC2MN,NCP0
            JIPC=JIPC0+IC2
            IPI=IPC(JIPC)
            DX2=XD(IPI)-X0
            DY2=YD(IPI)-Y0
            DZ2=ZD(IPI)-Z0
            DNMX=DY1*DZ2-DZ1*DY2
            DNMY=DZ1*DX2-DX1*DZ2
            DNMZ=DX1*DY2-DY1*DX2
            IF(DNMZ.GE.0.0)    GO TO 21
            DNMX=-DNMX
            DNMY=-DNMY
            DNMZ=-DNMZ
   21       NMX=NMX+DNMX
            NMY=NMY+DNMY
            NMZ=NMZ+DNMZ
   22     CONTINUE
   23   CONTINUE
        JPD0=5*IP0
        PD(JPD0-4)=-NMX/NMZ
        PD(JPD0-3)=-NMY/NMZ
   24 CONTINUE
```

```
C ESTIMATION OF ZXX, ZXY, AND ZYY
   30 DO 34  IP0=1,NDP0
        JPD0=JPD0+5
        X0=XD(IP0)
        JPD0=5*IP0
        Y0=YD(IP0)
        ZX0=PD(JPD0-4)
        ZY0=PD(JPD0-3)
        NMXX=0.0
        NMXY=0.0
        NMYX=0.0
        NMYY=0.0
        NMZ =0.0
        JIPC0=NCP0*(IP0-1)
        DO 33  IC1=1,NCPM1
          JIPC=JIPC0+IC1
          IPI=IPC(JIPC)
          DX1=XD(IPI)-X0
          DY1=YD(IPI)-Y0
          JPD=5*IPI
          DZX1=PD(JPD-4)-ZX0
          DZY1=PD(JPD-3)-ZY0
          IC2MN=IC1+1
          DO 32  IC2=IC2MN,NCP0
            JIPC=JIPC0+IC2
            IPI=IPC(JIPC)
            DX2=XD(IPI)-X0
            DY2=YD(IPI)-Y0
            JPD=5*IPI
            DZX2=PD(JPD-4)-ZX0
            DZY2=PD(JPD-3)-ZY0
            DNMXX=DY1*DZX2-DZX1*DY2
            DNMXY=DZX1*DX2-DX1*DZX2
            DNMYX=DY1*DZY2-DZY1*DY2
            DNMYY=DZY1*DX2-DX1*DZY2
            DNMZ =DX1*DY2 -DY1*DX2
            IF(DNMZ.GE.0.0)    GO TO 31
            DNMXX=-DNMXX
            DNMXY=-DNMXY
            DNMYX=-DNMYX
            DNMYY=-DNMYY
            DNMZ =-DNMZ
   31       NMXX=NMXX+DNMXX
            NMXY=NMXY+DNMXY
            NMYX=NMYX+DNMYX
            NMYY=NMYY+DNMYY
            NMZ =NMZ +DNMZ
   32     CONTINUE
   33   CONTINUE
        PD(JPD0-2)=-NMXX/NMZ
        PD(JPD0-1)=-(NMXY+NMYX)/(2.0*NMZ)
        PD(JPD0)  =-NMYY/NMZ
   34 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE  IDPTIP(XD,YD,ZD,NT,IPT,NL,IPL,PDD,ITI,XII,YII,
     1                   ZII)
C THIS SUBROUTINE PERFORMS PUNCTUAL INTERPOLATION OR EXTRAPO-
C LATION, I.E., DETERMINES THE Z VALUE AT A POINT.
C THE INPUT PARAMETERS ARE
C     XD,YD,ZD = ARRAYS CONTAINING THE X, Y, AND Z
C                COORDINATES OF DATA POINTS,
C     NT  = NUMBER OF TRIANGLES,
C     IPT = ARRAY CONTAINING THE POINT NUMBERS OF THE
C           VERTEXES OF THE TRIANGLES,
C     NL  = NUMBER OF BORDER LINE SEGMENTS,
C     IPL = ARRAY CONTAINING THE POINT NUMBERS OF THE END
C           POINTS OF THE BORDER LINE SEGMENTS AND THEIR
C           RESPECTIVE TRIANGLE NUMBERS,
C     PDD = ARRAY CONTAINING THE PARTIAL DERIVATIVES AT
C           THE DATA POINTS,
C     ITI = TRIANGLE NUMBER OF THE TRIANGLE IN WHICH LIES
C           THE POINT FOR WHICH INTERPOLATION IS TO BE
C           PERFORMED,
C     XII,YII = X AND Y COORDINATES OF THE POINT FOR WHICH
C               INTERPOLATION IS TO BE PERFORMED.
C THE OUTPUT PARAMETER IS
C     ZII = INTERPOLATED Z VALUE.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),ZD(100),IPT(585),IPL(300),
     1            PDD(500)
      COMMON/IDPI/NCF
      DIMENSION   X(3),Y(3),Z(3),PD(15),
     1            ZU(3),ZV(3),ZUU(3),ZUV(3),ZVV(3)
      REAL        LU,LV
      EQUIVALENCE (P5,P05)
      DATA  NCFMX/50/
C SETTING OF SOME LOCAL VARIABLES.
   10 ITO=ITI
      XIO=XII
      YIO=YII
      NTL=NT+NL
C DETERMINES IF SIMPLE INTERPOLATION IS APPLICABLE.
   20 IF(ITO.LE.NTL)        GO TO 30
      IL1=ITO/NTL
      IL2=ITO-IL1*NTL
      IL1T3=IL1*3
      IL2T3=IL2*3
      ITO=IPL(IL1T3)
      IF(IL1.NE.IL2)        GO TO 40
C CALCULATION OF ZII BY SIMPLE INTERPOLATION OR EXTRAPOLATION.
   30 ASSIGN 31 TO LBL
      GO TO 50
   31 ZII=ZIO
      RETURN
C CALCULATION OF ZII AS A WEIGHTED MEAN OF TWO EXTRAPOLATED
C VALUES.
   40 ASSIGN 41 TO LBL
      GO TO 50
   41 ZI1=ZIO
      ITO=IPL(IL2T3)
      ASSIGN 42 TO LBL
      GO TO 50
   42 ZI2=ZIO
C CALCULATES THE WEIGHTING COEFFICIENTS FOR EXTRAPOLATED VALUES.
```

```
   45 IP1=IPL(IL1T3-2)
      IP2=IPL(IL1T3-1)
      IP3=IPL(IL2T3-1)
      X1=XD(IP1)
      Y1=YD(IP1)
      X2=XD(IP2)
      Y2=YD(IP2)
      X3=XD(IP3)
      Y3=YD(IP3)
      DX02=XI0-X2
      DY02=YI0-Y2
      DX32=X3-X2
      DY32=Y3-Y2
      DX21=X2-X1
      DY21=Y2-Y1
      W1=(DX02*DX32+DY02*DY32)**2/(DX32*DX32+DY32*DY32)
      W2=(DX02*DX21+DY02*DY21)**2/(DX21*DX21+DY21*DY21)
C CALCULATES ZII AS A WEIGHTED MEAN.
   46 ZII=(W1*ZI1+W2*ZI2)/(W1+W2)
      RETURN
C INTERNAL ROUTINE FOR PUNCTUAL INTERPOLATION.
C CHECKS IF THE NECESSARY COEFFICIENTS HAVE BEEN CALCULATED.
   50 IF(NCF.EQ.0)           GO TO 60
      IF(NCF.EQ.IT0)         GO TO 70
C CALCULATION OF NEW COEFFICIENT VALUES.
C DETERMINES THE COEFFICIENTS FOR THE COORDINATE SYSTEM TRANS-
C FORMATION FROM THE X-Y SYSTEM TO THE U-V SYSTEM, AND CALCU-
C LATES THE COEFFICIENTS OF THE POLYNOMIAL FOR INTERPOLATION.
C LOADS COORDINATE AND PARTIAL DERIVATIVE VALUES AT THE
C VERTEXES.
   60 NCF=IT0
      JIPT=3*(IT0-1)
      JPD=0
      DO 62  I=1,3
        JIPT=JIPT+1
        IDP=IPT(JIPT)
        X(I)=XD(IDP)
        Y(I)=YD(IDP)
        Z(I)=ZD(IDP)
        JPDD=5*(IDP-1)
        DO 61  KPD=1,5
          JPD=JPD+1
          JPDD=JPDD+1
          PD(JPD)=PDD(JPDD)
   61   CONTINUE
   62 CONTINUE
C DETERMINING THE COEFFICIENTS FOR THE COORDINATE SYSTEM
C TRANSFORMATION FROM THE X-Y SYSTEM TO THE U-V SYSTEM
C AND VICE VERSA
   63 X0=X(1)
      Y0=Y(1)
      A=X(2)-X0
      B=X(3)-X0
      C=Y(2)-Y0
      D=Y(3)-Y0
      AD=A*D
      BC=B*C
      DLT=AD-BC
      AP= D/DLT
      BP=-B/DLT
```

```
      CP=-C/DLT
      DP= A/DLT
C CONVERSION OF THE PARTIAL DERIVATIVES AT THE VERTEXES OF THE
C TRIANGLE FOR THE U-V COORDINATE SYSTEM
   64 AA=A*A
      ACT2=2.0*A*C
      CC=C*C
      AB=A*B
      ADBC=AD+BC
      CD=C*D
      BB=B*B
      BDT2=2.0*B*D
      DD=D*D
      DO 65  I=1,3
        JPD=5*I
        ZU(I)=A*PD(JPD-4)+C*PD(JPD-3)
        ZV(I)=B*PD(JPD-4)+D*PD(JPD-3)
        ZUU(I)=AA*PD(JPD-2)+ACT2*PD(JPD-1)+CC*PD(JPD)
        ZUV(I)=AB*PD(JPD-2)+ADBC*PD(JPD-1)+CD*PD(JPD)
        ZVV(I)=BB*PD(JPD-2)+BDT2*PD(JPD-1)+DD*PD(JPD)
   65 CONTINUE
C CALCULATION OF THE COEFFICIENTS OF THE POLYNOMIAL
   66 P00=Z(1)
      P10=ZU(1)
      P01=ZV(1)
      P20=0.5*ZUU(1)
      P11=ZUV(1)
      P02=0.5*ZVV(1)
      H1=Z(2)-P00-P10-P20
      H2=ZU(2)-P10-ZUU(1)
      H3=ZUU(2)-ZUU(1)
      P30= 10.0*H1-4.0*H2+0.5*H3
      P40=-15.0*H1+7.0*H2     -H3
      P50=  6.0*H1-3.0*H2+0.5*H3
      H1=Z(3)-P00-P01-P02
      H2=ZV(3)-P01-ZVV(1)
      H3=ZVV(3)-ZVV(1)
      P03= 10.0*H1-4.0*H2+0.5*H3
      P04=-15.0*H1+7.0*H2     -H3
      P05=  6.0*H1-3.0*H2+0.5*H3
      LU=SQRT(AA+CC)
      LV=SQRT(BB+DD)
      THXU=ATAN2(C,A)
      THUV=ATAN2(D,B)-THXU
      CSUV=COS(THUV)
      P41=5.0*LV*CSUV/LU*P50
      P14=5.0*LU*CSUV/LV*P05
      H1=ZV(2)-P01-P11-P41
      H2=ZUV(2)-P11-4.0*P41
      P21= 3.0*H1-H2
      P31=-2.0*H1+H2
      H1=ZU(3)-P10-P11-P14
      H2=ZUV(3)-P11-4.0*P14
      P12= 3.0*H1-H2
      P13=-2.0*H1+H2
      THUS=ATAN2(D-C,B-A)-THXU
      THSV=THUV-THUS
      AA= SIN(THSV)/LU
      BB=-COS(THSV)/LU
      CC= SIN(THUS)/LV
```

```
      DD= COS(THUS)/LV
      AC=AA*CC
      AD=AA*DD
      BC=BB*CC
      G1=AA*AC*(3.0*BC+2.0*AD)
      G2=CC*AC*(3.0*AD+2.0*BC)
      H1=-AA*AA*AA*(5.0*AA*BB*P50+(4.0*BC+AD)*P41)
     1   -CC*CC*CC*(5.0*CC*DD*P05+(4.0*AD+BC)*P14)
      H2=0.5*ZVV(2)-P02-P12
      H3=0.5*ZUU(3)-P20-P21
      P22=(G1*H2+G2*H3-H1)/(G1+G2)
      P32=H2-P22
      P23=H3-P22
C TRANSFORMATION OF THE COORDINATE SYSTEM FROM X-Y TO U-V
   70 DX=XII-X0
      DY=YII-Y0
      U=AP*DX+BP*DY
      V=CP*DX+DP*DY
C EVALUATION OF THE POLYNOMIAL
   75 P0=P00+U*(P10+U*(P20+U*(P30+U*(P40+U*P50))))
      P1=P01+U*(P11+U*(P21+U*(P31+U*P41)))
      P2=P02+U*(P12+U*(P22+U*P32))
      P3=P03+U*(P13+U*P23)
      P4=P04+U*P14
      ZI0=P0+V*(P1+V*(P2+V*(P3+V*(P4+V*P5))))
      GO TO LBL, (31,41,42)
      END
```

```
      SUBROUTINE  IDTANG(NDP,XD,YD,NT,IPT,NL,IPL,IWL,IWP,WK)
C THIS SUBROUTINE PERFORMS TRIANGULATION.  IT DIVIDES THE X-Y
C PLANE INTO A NUMBER OF TRIANGLES ACCORDING TO GIVEN DATA
C POINTS IN THE PLANE, DETERMINES LINE SEGMENTS THAT FORM THE
C BORDER OF DATA AREA, AND DETERMINES THE TRIANGLE NUMBERS
C CORRESPONDING TO THE BORDER LINE SEGMENTS.
C AT COMPLETION, POINT NUMBERS OF THE VERTEXES OF EACH TRIANGLE
C ARE LISTED COUNTER-CLOCKWISE.  POINT NUMBERS OF THE END POINTS
C OF EACH BORDER LINE SEGMENT ARE LISTED COUNTER-CLOCKWISE,
C LISTING ORDER OF THE LINE SEGMENTS BEING COUNTER-CLOCKWISE.
C THE INPUT PARAMETERS ARE
C     NDP = NUMBER OF DATA POINTS,
C     XD  = ARRAY OF DIMENSION NDP CONTAINING THE
C           X COORDINATES OF THE DATA POINTS,
C     YD  = ARRAY OF DIMENSION NDP CONTAINING THE
C           Y COORDINATES OF THE DATA POINTS.
C THE OUTPUT PARAMETERS ARE
C     NT  = NUMBER OF TRIANGLES,
C     IPT = ARRAY OF DIMENSION 6*NDP-15, WHERE THE POINT
C           NUMBERS OF THE VERTEXES OF THE (IT)TH TRIANGLE
C           ARE TO BE STORED AS THE (3*IT-2)ND, (3*IT-1)ST,
C           AND (3*IT)TH ELEMENTS, IT=1,2,...,NT,
C     NL  = NUMBER OF BORDER LINE SEGMENTS,
C     IPL = ARRAY OF DIMENSION 6*NDP, WHERE THE POINT
C           NUMBERS OF THE END POINTS OF THE (IL)TH BORDER
C           LINE SEGMENT AND ITS RESPECTIVE TRIANGLE NUMBER
C           ARE TO BE STORED AS THE (3*IL-2)ND, (3*IL-1)ST,
C           AND (3*IL)TH ELEMENTS, IL=1,2,..., NL.
C THE OTHER PARAMETERS ARE
C     IWL = INTEGER ARRAY OF DIMENSION 18*NDP USED
C           INTERNALLY AS A WORK AREA,
C     IWP = INTEGER ARRAY OF DIMENSION NDP USED
C           INTERNALLY AS A WORK AREA,
C     WK  = ARRAY OF DIMENSION NDP USED INTERNALLY AS A
C           WORK AREA.
C DECLARATION STATEMENTS
      DIMENSION   XD(100),YD(100),IPT(585),IPL(600),
     1            IWL(1800),IWP(100),WK(100)
      DIMENSION   ITF(2)
      DATA  RATIO/1.0E-6/, NREP/100/, LUN/6/
C STATEMENT FUNCTIONS
      DSQF(X1,Y1,X2,Y2)=(X2-X1)**2+(Y2-Y1)**2
      SIDE(X1,Y1,X2,Y2,X3,Y3)=(Y3-Y1)*(X2-X1)-(X3-X1)*(Y2-Y1)
C PRELIMINARY PROCESSING
   10 NDP0=NDP
      NDPM1=NDP0-1
      IF(NDP0.LT.4)       GO TO 90
C DETERMINES THE CLOSEST PAIR OF DATA POINTS AND THEIR MIDPOINT.
   20 DSQMN=DSQF(XD(1),YD(1),XD(2),YD(2))
      IPMN1=1
      IPMN2=2
      DO 22  IP1=1,NDPM1
        X1=XD(IP1)
        Y1=YD(IP1)
        IP1P1=IP1+1
        DO 21  IP2=IP1P1,NDP0
          DSQI=DSQF(X1,Y1,XD(IP2),YD(IP2))
          IF(DSQI.EQ.0)          GO TO 91
          IF(DSQI.GE.DSQMN)      GO TO 21
          DSQMN=DSQI
```

```
          IPMN1=IP1
          IPMN2=IP2
   21   CONTINUE
   22 CONTINUE
      DSQ12=DSQMN
      XDMP=(XD(IPMN1)+XD(IPMN2))/2.0
      YDMP=(YD(IPMN1)+YD(IPMN2))/2.0
C SORTS THE OTHER (NDP-2) DATA POINTS IN ASCENDING ORDER OF
C DISTANCE FROM THE MIDPOINT AND STORES THE SORTED DATA POINT
C NUMBERS IN THE IWP ARRAY.
   30 JP1=2
      DO 31  IP1=1,NDP0
        IF(IP1.EQ.IPMN1.OR.IP1.EQ.IPMN2)       GO TO 31
        JP1=JP1+1
        IWP(JP1)=IP1
        WK(JP1)=DSQF(XDMP,YDMP,XD(IP1),YD(IP1))
   31 CONTINUE
      DO 33  JP1=3,NDPM1
        DSQMN=WK(JP1)
        JPMN=JP1
        DO 32  JP2=JP1,NDP0
          IF(WK(JP2).GE.DSQMN)      GO TO 32
          DSQMN=WK(JP2)
          JPMN=JP2
   32   CONTINUE
        ITS=IWP(JP1)
        IWP(JP1)=IWP(JPMN)
        IWP(JPMN)=ITS
        WK(JPMN)=WK(JP1)
   33 CONTINUE
C IF NECESSARY, MODIFIES THE ORDERING IN SUCH A WAY THAT THE
C FIRST THREE DATA POINTS ARE NOT COLLINEAR.
   35 AR=DSQ12*RATIO
      X1=XD(IPMN1)
      Y1=YD(IPMN1)
      DX21=XD(IPMN2)-X1
      DY21=YD(IPMN2)-Y1
      DO 36  JP=3,NDP0
        IP=IWP(JP)
        IF(ABS((YD(IP)-Y1)*DX21-(XD(IP)-X1)*DY21).GT.AR)
     1               GO TO 37
   36 CONTINUE
      GO TO 92
   37 IF(JP.EQ.3)    GO TO 40
      JPMX=JP
      IWP(3)=IP
      JP=JPMX+1
      DO 38  JPC=4,JPMX
        JP=JP-1
        IWP(JP)=IWP(JP-1)
   38 CONTINUE
C FORMS THE FIRST TRIANGLE.  STORES POINT NUMBERS OF THE VER-
C TEXES OF THE TRIANGLE IN THE IPT ARRAY, AND STORES POINT NUM-
C BERS OF THE BORDER LINE SEGMENTS AND THE TRIANGLE NUMBER IN
C THE IPL ARRAY.
   40 IP1=IPMN1
      IP2=IPMN2
      IP3=IWP(3)
      IF(SIDE(XD(IP1),YD(IP1),XD(IP2),YD(IP2),XD(IP3),YD(IP3))
     1     .GE.0.0)         GO TO 41
```

```
      IP1=IPMN2
      IP2=IPMN1
   41 NT0=1
      NTT3=3
      IPT(1)=IP1
      IPT(2)=IP2
      IPT(3)=IP3
      NL0=3
      NLT3=9
      IPL(1)=IP1
      IPL(2)=IP2
      IPL(3)=1
      IPL(4)=IP2
      IPL(5)=IP3
      IPL(6)=1
      IPL(7)=IP3
      IPL(8)=IP1
      IPL(9)=1
C ADDS THE REMAINING (NDP-3) DATA POINTS, ONE BY ONE.
   50 DO 79  JP1=4,NDP0
        IP1=INP(JP1)
        X1=XD(IP1)
        Y1=YD(IP1)
C - DETERMINES THE VISIBLE BORDER LINE SEGMENTS.
        IP2=IPL(1)
        JPMN=1
        DXMN=XD(IP2)-X1
        DYMN=YD(IP2)-Y1
        ARMN=(DXMN**2+DYMN**2)*RATIO
        JPMX=1
        DXMX=DXMN
        DYMX=DYMN
        ARMX=ARMN
        DO 52  JP2=2,NL0
          IP2=IPL(3*JP2-2)
          DX=XD(IP2)-X1
          DY=YD(IP2)-Y1
          IF(DY*DXMN-DX*DYMN.GE.-ARMN)    GO TO 51
          JPMN=JP2
          DXMN=DX
          DYMN=DY
          ARMN=(DXMN**2+DYMN**2)*RATIO
          GO TO 52
   51     IF(DY*DXMX-DX*DYMX.LT.-ARMX)    GO TO 52
          JPMX=JP2
          DXMX=DX
          DYMX=DY
          ARMX=(DXMX**2+DYMX**2)*RATIO
   52   CONTINUE
        IF(JPMX.LT.JPMN)   JPMX=JPMX+NL0
        NSH=JPMN-1
        IF(NSH.LE.0)        GO TO 60
C - SHIFTS (ROTATES) THE IPL ARRAY TO HAVE THE INVISIBLE BORDER
C - LINE SEGMENTS CONTAINED IN THE FIRST PART OF THE IPL ARRAY.
        NSHT3=NSH*3
        DO 53  JP2T3=3,NSHT3,3
          JP3T3=JP2T3+NLT3
          IPL(JP3T3-2)=IPL(JP2T3-2)
          IPL(JP3T3-1)=IPL(JP2T3-1)
          IPL(JP3T3)   =IPL(JP2T3)
```

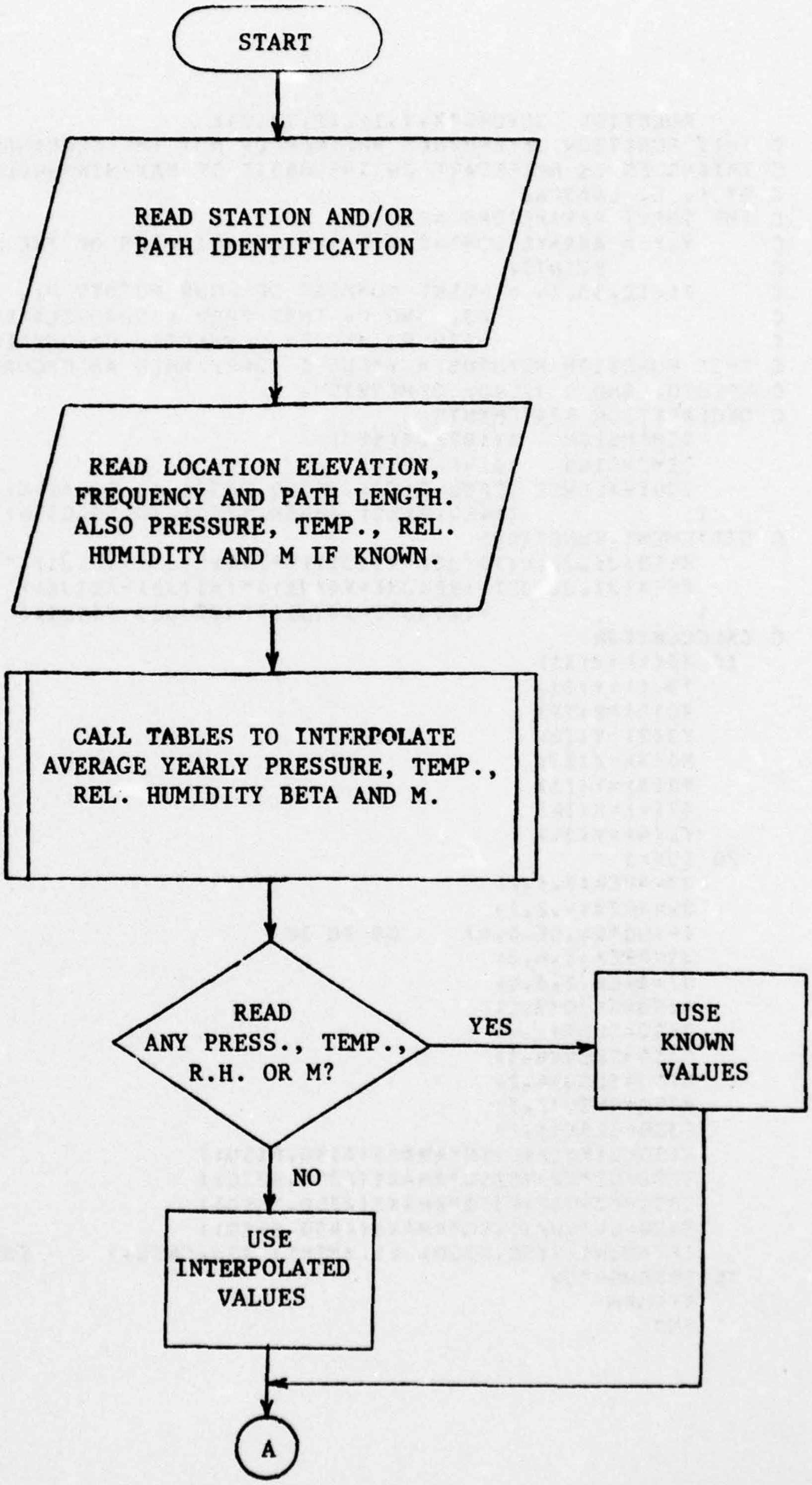
```
53    CONTINUE
      DO 54  JP2T3=3,NLT3,3
        JP3T3=JP2T3+NSHT3
        IPL(JP2T3-2)=IPL(JP3T3-2)
        IPL(JP2T3-1)=IPL(JP3T3-1)
        IPL(JP2T3)  =IPL(JP3T3)
54    CONTINUE
      JPMX=JPMX-NSH
C - ADDS TRIANGLES TO THE IPT ARRAY, UPDATES BORDER LINE
C - SEGMENTS IN THE IPL ARRAY, AND SETS FLAGS FOR THE BORDER
C - LINE SEGMENTS TO BE REEXAMINED IN THE IWL ARRAY.
60    JWL=0
      DO 64  JP2=JPMX,NL0
        JP2T3=JP2*3
        IPL1=IPL(JP2T3-2)
        IPL2=IPL(JP2T3-1)
        IT  =IPL(JP2T3)
C - - ADDS A TRIANGLE TO THE IPT ARRAY.
        NT0=NT0+1
        NTT3=NTT3+3
        IPT(NTT3-2)=IPL2
        IPT(NTT3-1)=IPL1
        IPT(NTT3)  =IP1
C - - UPDATES BORDER LINE SEGMENTS IN THE IPL ARRAY.
        IF(JP2.NE.JPMX)       GO TO 61
        IPL(JP2T3-1)=IP1
        IPL(JP2T3)  =NT0
61      IF(JP2.NE.NL0)        GO TO 62
        NLN=JPMX+1
        NLNT3=NLN*3
        IPL(NLNT3-2)=IP1
        IPL(NLNT3-1)=IPL(1)
        IPL(NLNT3)  =NT0
C - - DETERMINES THE VERTEX THAT DOES NOT LIE ON THE BORDER
C - - LINE SEGMENTS.
62      ITT3=IT*3
        IPTI=IPT(ITT3-2)
        IF(IPTI.NE.IPL1.AND.IPTI.NE.IPL2)   GO TO 63
        IPTI=IPT(ITT3-1)
        IF(IPTI.NE.IPL1.AND.IPTI.NE.IPL2)   GO TO 63
        IPTI=IPT(ITT3)
C - - CHECKS IF THE EXCHANGE IS NECESSARY.
63      IF(IDXCHG(XD,YD,IP1,IPTI,IPL1,IPL2).EQ.0)      GO TO 64
C - - MODIFIES THE IPT ARRAY WHEN NECESSARY.
        IPT(ITT3-2)=IPTI
        IPT(ITT3-1)=IPL1
        IPT(ITT3)  =IP1
        IPT(NTT3-1)=IPTI
        IF(JP2.EQ.JPMX)      IPL(JP2T3)=IT
        IF(JP2.EQ.NL0.AND.IPL(3).EQ.IT)       IPL(3)=NT0
C - - SETS FLAGS IN THE IWL ARRAY.
        JWL=JWL+4
        IWL(JWL-3)=IPL1
        IWL(JWL-2)=IPTI
        IWL(JWL-1)=IPTI
        IWL(JWL)  =IPL2
64    CONTINUE
      NL0=NLN
      NLT3=NLNT3
      NLF=JWL/2
```

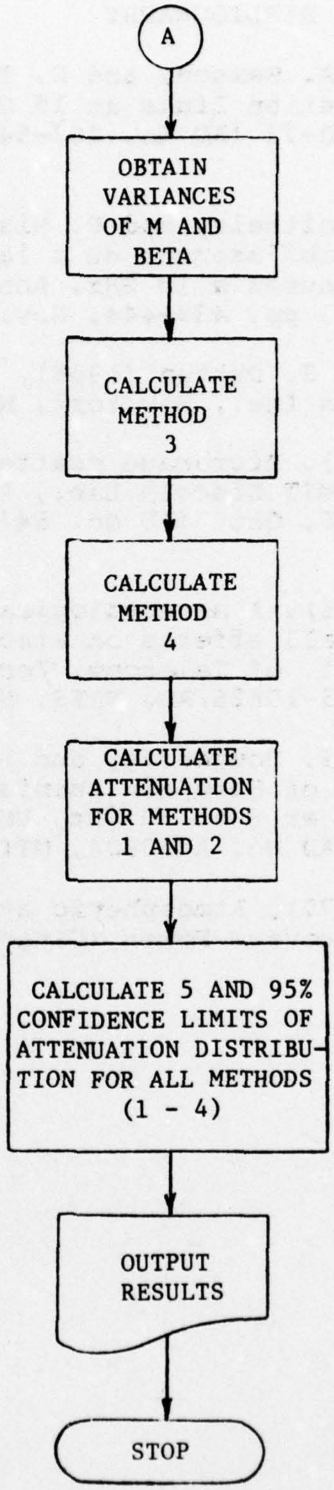
```
      IF(NLF.EQ.0)        GO TO 79
C - IMPROVES TRIANGULATION.
   70 NTT3P3=NTT3+3
      DO 78  IREP=1,NREP
        DO 76  ILF=1,NLF
          ILFT2=ILF*2
          IPL1=IWL(ILFT2-1)
          IPL2=IWL(ILFT2)
C - - LOCATES IN THE IPT ARRAY TWO TRIANGLES ON BOTH SIDES OF
C - - THE FLAGGED LINE SEGMENT.
          NTF=0
          DO 71  ITT3R=3,NTT3,3
            ITT3=NTT3P3-ITT3R
            IPT1=IPT(ITT3-2)
            IPT2=IPT(ITT3-1)
            IPT3=IPT(ITT3)
            IF(IPL1.NE.IPT1.AND.IPL1.NE.IPT2.AND.
     1         IPL1.NE.IPT3)       GO TO 71
            IF(IPL2.NE.IPT1.AND.IPL2.NE.IPT2.AND.
     1         IPL2.NE.IPT3)       GO TO 71
            NTF=NTF+1
            ITF(NTF)=ITT3/3
            IF(NTF.EQ.2)       GO TO 72
   71     CONTINUE
          IF(NTF.LT.2)         GO TO 76
C - - DETERMINES THE VERTEXES OF THE TRIANGLES THAT DO NOT LIE
C - - ON THE LINE SEGMENT.
   72     IT1T3=ITF(1)*3
          IPTI1=IPT(IT1T3-2)
          IF(IPTI1.NE.IPL1.AND.IPTI1.NE.IPL2)      GO TO 73
          IPTI1=IPT(IT1T3-1)
          IF(IPTI1.NE.IPL1.AND.IPTI1.NE.IPL2)      GO TO 73
          IPTI1=IPT(IT1T3)
   73     IT2T3=ITF(2)*3
          IPTI2=IPT(IT2T3-2)
          IF(IPTI2.NE.IPL1.AND.IPTI2.NE.IPL2)      GO TO 74
          IPTI2=IPT(IT2T3-1)
          IF(IPTI2.NE.IPL1.AND.IPTI2.NE.IPL2)      GO TO 74
          IPTI2=IPT(IT2T3)
C - - CHECKS IF THE EXCHANGE IS NECESSARY.
   74     IF(IDXCHG(XD,YD,IPTI1,IPTI2,IPL1,IPL2).EQ.0)
     1       GO TO 76
C - - MODIFIES THE IPT ARRAY WHEN NECESSARY.
          IPT(IT1T3-2)=IPTI1
          IPT(IT1T3-1)=IPTI2
          IPT(IT1T3)  =IPL1
          IPT(IT2T3-2)=IPTI2
          IPT(IT2T3-1)=IPTI1
          IPT(IT2T3)  =IPL2
C - - SETS NEW FLAGS.
          JWL=JWL+8
          IWL(JWL-7)=IPL1
          IWL(JWL-6)=IPTI1
          IWL(JWL-5)=IPTI1
          IWL(JWL-4)=IPL2
          IWL(JWL-3)=IPL2
          IWL(JWL-2)=IPTI2
          IWL(JWL-1)=IPTI2
          IWL(JWL)  =IPL1
          DO 75  JLT3=3,NLT3,3
```

```
      IPLJ1=IPL(JLT3-2)
      IPLJ2=IPL(JLT3-1)
      IF((IPLJ1.EQ.IPL1.AND.IPLJ2.EQ.IPTI2).OR.
   1     (IPLJ2.EQ.IPL1.AND.IPLJ1.EQ.IPTI2))
   2                         IPL(JLT3)=ITF(1)
      IF((IPLJ1.EQ.IPL2.AND.IPLJ2.EQ.IPTI1).OR.
   1     (IPLJ2.EQ.IPL2.AND.IPLJ1.EQ.IPTI1))
   2                         IPL(JLT3)=ITF(2)
   75     CONTINUE
   76   CONTINUE
        NLFC=NLF
        NLF=JWL/2
        IF(NLF.EQ.NLFC)       GO TO 79
C - - RESETS THE IWL ARRAY FOR THE NEXT ROUND.
        JWL=0
        JWL1MN=(NLFC+1)*2
        NLFT2=NLF*2
        DO 77  JWL1=JWL1MN,NLFT2,2
          JWL=JWL+2
          IWL(JWL-1)=IWL(JWL1-1)
          IWL(JWL)  =IWL(JWL1)
   77   CONTINUE
        NLF=JWL/2
   78 CONTINUE
   79 CONTINUE
C REARRANGE THE IPT ARRAY SO THAT THE VERTEXES OF EACH TRIANGLE
C ARE LISTED COUNTER-CLOCKWISE.
   80 DO 81  ITT3=3,NTT3,3
        IP1=IPT(ITT3-2)
        IP2=IPT(ITT3-1)
        IP3=IPT(ITT3)
        IF(SIDE(XD(IP1),YD(IP1),XD(IP2),YD(IP2),XD(IP3),YD(IP3))
   1       .GE.0.0)        GO TO 81
        IPT(ITT3-2)=IP2
        IPT(ITT3-1)=IP1
   81 CONTINUE
      NT=NT0
      NL=NL0
      RETURN
C ERROR EXIT
   90 WRITE (LUN,2090)   NDP0
      GO TO 93
   91 WRITE (LUN,2091)   NDP0,IP1,IP2,X1,Y1
      GO TO 93
   92 WRITE (LUN,2092)   NDP0
   93 WRITE (LUN,2093)
      NT=0
      RETURN
C FORMAT STATEMENTS
 2090 FORMAT(1X/23H ***   NDP LESS THAN 4./8H   NDP =,I5)
 2091 FORMAT(1X/29H ***   IDENTICAL DATA POINTS./
   1   8H   NDP =,I5,5X,5HIP1 =,I5,5X,5HIP2 =,I5,
   2   5X,4HXD =,E12.4,5X,4HYD =,E12.4)
 2092 FORMAT(1X/33H ***   ALL COLLINEAR DATA POINTS./
   1   8H   NDP =,I5)
 2093 FORMAT(35H ERROR DETECTED IN ROUTINE   IDTANG/)
      END
```

```
      FUNCTION  IDXCHG(X,Y,I1,I2,I3,I4)
C THIS FUNCTION DETERMINES WHETHER OR NOT THE EXCHANGE OF TWO
C TRIANGLES IS NECESSARY ON THE BASIS OF MAX-MIN-ANGLE CRITERION
C BY C. L. LAWSON.
C THE INPUT PARAMETERS ARE
C     X,Y = ARRAYS CONTAINING THE COORDINATES OF THE DATA
C           POINTS,
C     I1,I2,I3,I4 = POINT NUMBERS OF FOUR POINTS P1, P2,
C                   P3, AND P4 THAT FORM A QUADRILATERAL
C                   WITH P3 AND P4 CONNECTED DIADONALLY.
C THIS FUNCTION RETURNS A VALUE 1 (ONE) WHEN AN EXCHANGE IS
C NEEDED, AND 0 (ZERO) OTHERWISE.
C DECLARATION STATEMENTS
      DIMENSION   X(100),Y(100)
      DIMENSION   X0(4),Y0(4)
      EQUIVALENCE (C2SQ,C1SQ),(A3SQ,B2SQ),(B3SQ,A1SQ),
     1            (A4SQ,B1SQ),(B4SQ,A2SQ),(C4SQ,C3SQ)
C STATEMENT FUNCTIONS
      SLSQ(J1,J2)=(X0(J2)-X0(J1))**2+(Y0(J2)-Y0(J1))**2
      AREA(J1,J2,J3)=(Y0(J3)-Y0(J1))*(X0(J2)-X0(J1))
     1              -(X0(J3)-X0(J1))*(Y0(J2)-Y0(J1))
C CALCULATION
   10 X0(1)=X(I1)
      Y0(1)=Y(I1)
      X0(2)=X(I2)
      Y0(2)=Y(I2)
      X0(3)=X(I3)
      Y0(3)=Y(I3)
      X0(4)=X(I4)
      Y0(4)=Y(I4)
   20 IDX=0
      U3=AREA(3,1,2)
      U4=AREA(4,2,1)
      IF(U3*U4.LE.0.0)     GO TO 30
      U1=AREA(1,4,3)
      U2=AREA(2,3,4)
      A1SQ=SLSQ(3,1)
      B1SQ=SLSQ(1,4)
      C1SQ=SLSQ(4,3)
      A2SQ=SLSQ(4,2)
      B2SQ=SLSQ(2,3)
      C3SQ=SLSQ(1,2)
      S1SQ=U1*U1/(C1SQ*AMAX1(A1SQ,B1SQ))
      S2SQ=U2*U2/(C2SQ*AMAX1(A2SQ,B2SQ))
      S3SQ=U3*U3/(C3SQ*AMAX1(A3SQ,B3SQ))
      S4SQ=U4*U4/(C4SQ*AMAX1(A4SQ,B4SQ))
      IF(AMIN1(S1SQ,S2SQ).LT.AMIN1(S3SQ,S4SQ))      IDX=1
   30 IDXCHG=IDX
      RETURN
      END
```

Flow Diagram of Program PREDIC




A
OBTAIN VARIANCES OF M AND BETA
CALCULATE METHOD 3
CALCULATE METHOD 4
CALCULATE ATTENUATION FOR METHODS 1 AND 2
CALCULATE 5 AND 95% CONFIDENCE LIMITS OF ATTENUATION DISTRIBUTION FOR ALL METHODS (1 - 4)
OUTPUT RESULTS
STOP

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

A computer program in FORTRAN IV language entitled PROGRAM PREDIC has been prepared. This calculates performance prediction and its 5 and 95 percent confidence levels for microwave terrestrial links (8 to 30 GHz) operating in the European Wide-band Communication System (EWCS). This program predicts atmospheric attenuation, principally due to rain, at the indicated frequencies.

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